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THE WORLDWIDE TECHNOLOGY WEEKLY

DECEMBER 16, 1985

HOW DOD'S VHSIC IS SPREADING

DESIGNS MULTIPLY AS CHIPS START ROLLING OFF ADVANCED LINES

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SMART BUBBLES SIMPLIFY ASSOCIATIVE MEMORY DESIGN/39

MCC: THE RESEARCH CO-OP'S SURPRISING FAST START/49

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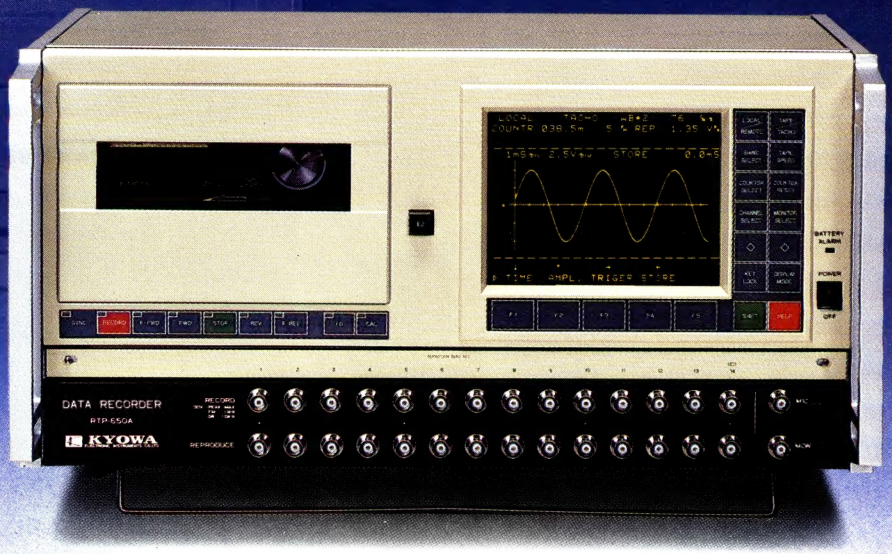

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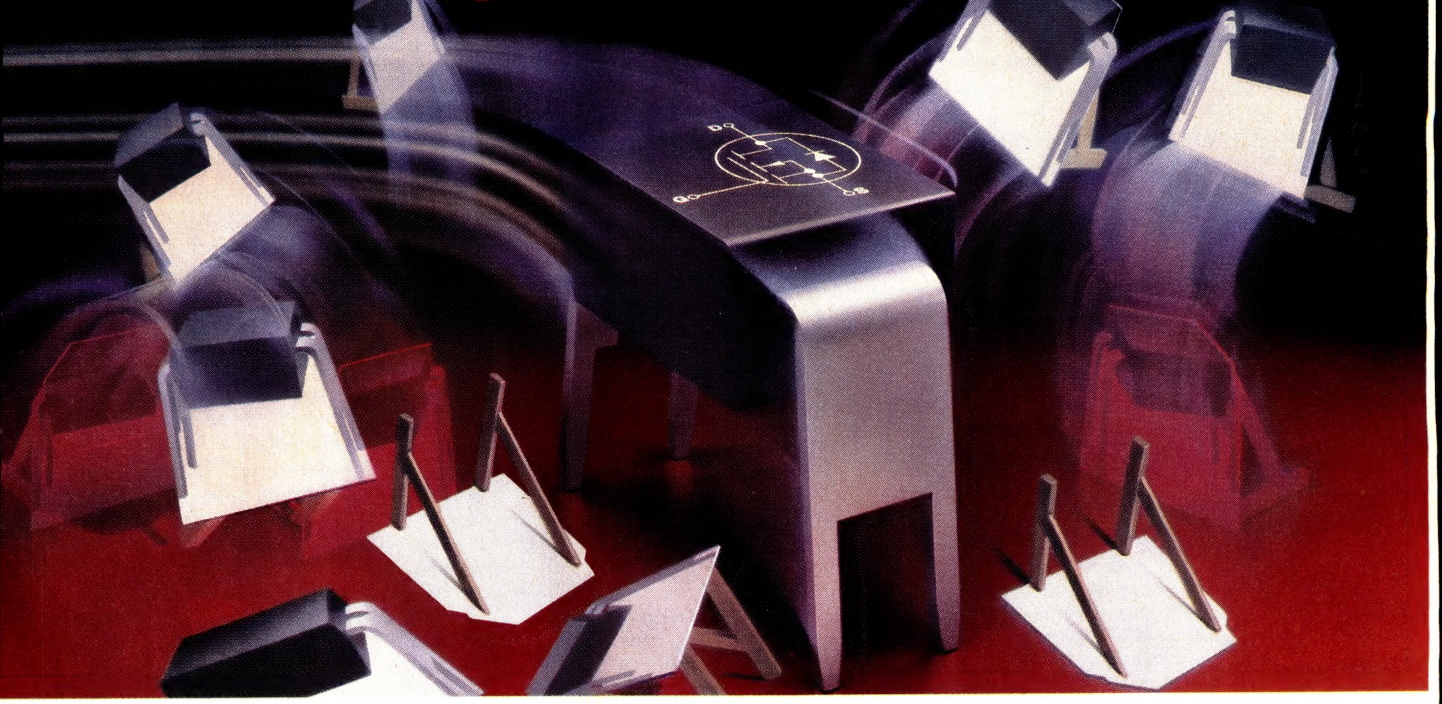

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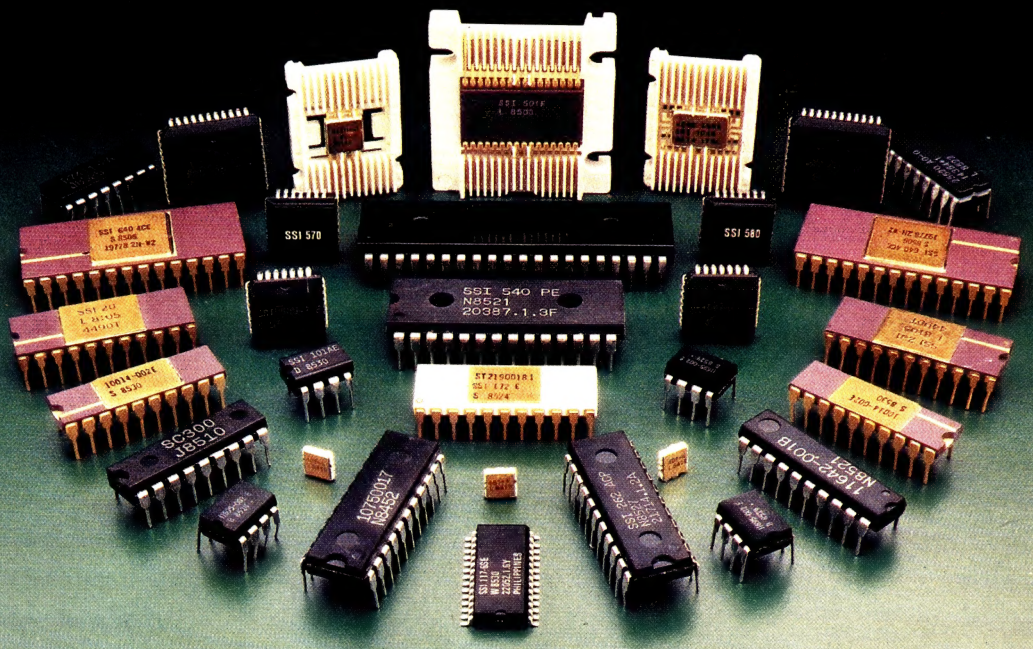

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DECEMBER 16, 1985 VOLUME 58, NO. 50

Electronics

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Cover sculpture by Robert Strimban

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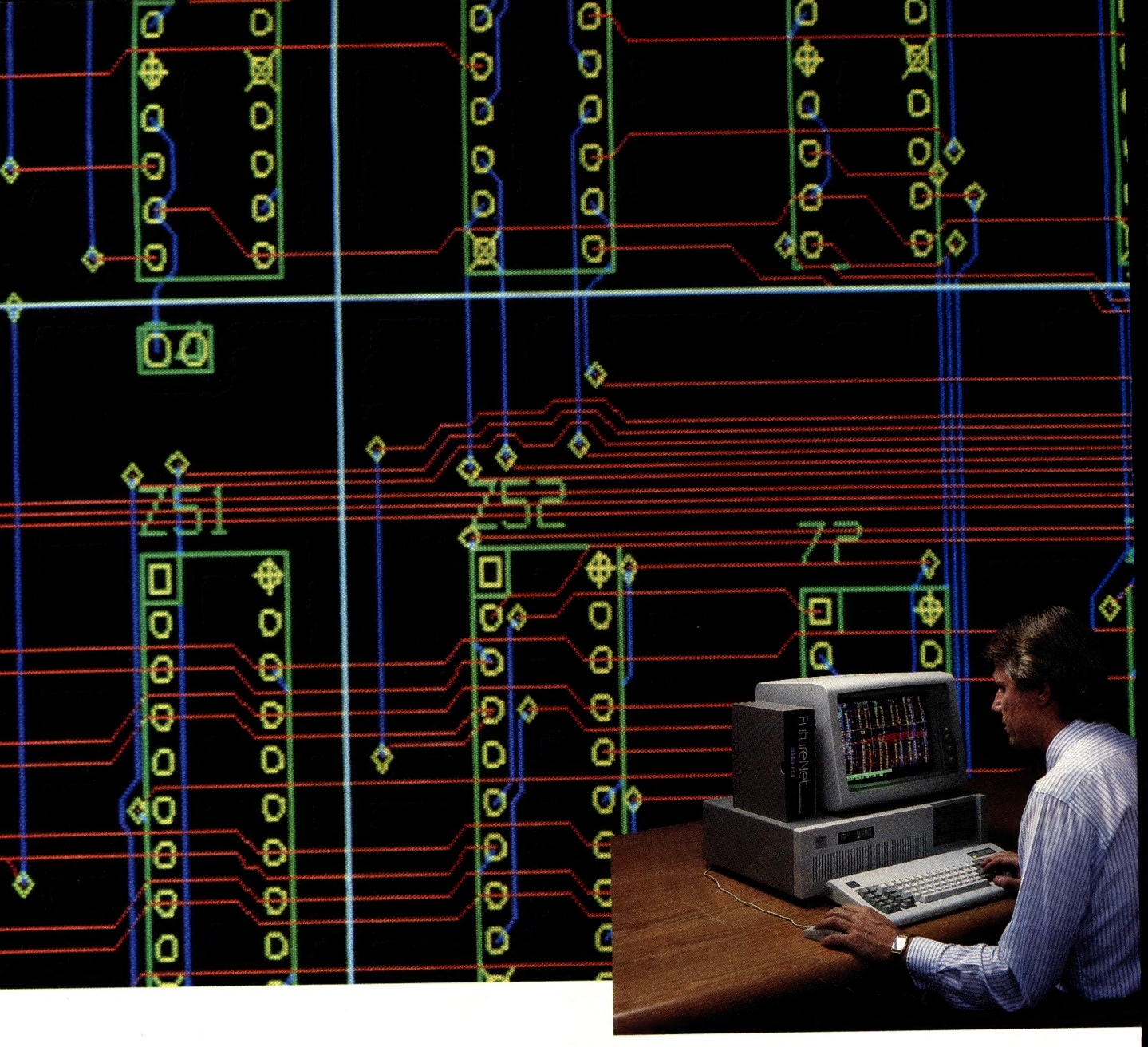

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After three years at the helm of a precedent-setting research consortium, retired Adm. B. R. (Bobby) Inman clearly is still having fun with his job. That's the assessment of Rob Lineback, our Dallas bureau manager, whose close look at Inman's Microelectronics & Computer Technology Corp. begins on p. 49.

MCC not only is beginning to shape tomorrow's electronics technologies, Inman says, it is also proving a point about American business: it is possible to cooperate in research and compete in the market.

Research at the Austin, Texas, company got under way officially a year ago. MCC is now ahead of the timetable it has set for transferring technology to its sponsors, and some of them are even preparing to go to market with commercial products that are based on the consortium's initial deliveries of research results—all in all, a good time for us to examine what has been going on and what will be happening at MCC.

Lineback has been following the consortium since its inception. He began interviewing Inman on a regular basis in the middle of 1983, when the consortium selected Austin, the site of the University of Texas, as its headquarters.

"Inman's attitude has changed since then," Lineback observes. "In 1983, he was concerned about whether he could recruit top talent to MCC in central Texas. By early 1984, the MCC chief was clearly at ease with that, sitting with his feet on the coffee table in his office while talking about his growing staff. But when the topic changed to transferring technology to MCC's sponsoring firms, Inman sat up straight and speculated about the tough task ahead."

VET. Lineback has covered MCC since its start.

Inman agrees. Now that MCC has conducted a number of technology deliveries, "my concern has not diminished for the long term, but I'm more comfortable as I watch the process."

Inman's staff seems to have heightened his interest in the research and development venture. "I've been privileged to draw on just a lot of crackerjack talent, and it's been fun working with them," adds Inman, a Texas native.

Lineback cautions, "Don't look for Inman to retire quietly in the Texas Hill Country after winding up a highly visible career with MCC." In September, Inman renewed for one year his contract as president. He says he will "be looking at it in the year and see where we are" for another extension.

"There are a lot of offers, but we are still building and it is exciting around here," Inman adds quickly. "I have tried to be very careful not to make MCC personality-dependent. But we still don't yet have it all of the way home—everything built into it to run smoothly, humming along. So, at this point, I'm not inclined to walk away."

Laurence Altman

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LETTERS

Intel takes gloves off

To the editor: The cover of your Nov. 25 issue does a disservice to your readers and to the large number of companies with a well-founded stake in the Multibus architecture. The cover illustration and article title ["Battle of the buses: And the winner is... VMEbus"] sacrifice the facts and clarity present in the article for sensationalism.

Contrary to the claim that VMEbus is the "winner" in the 32-bit "bus war," data cited in your article shows that the Multibus I and II bus architectures are the dominant architectures today—and will remain so through 1988. By your own data sources, the dominance of Multibus-based designs will grow steadily over the next several years to 44% of the market by 1988. The unique 32-bit and multiprocessing capabilities of the Multibus II architecture are here now, as 32-bit microprocessors are becoming widely available.

The recent decision in favor of Multibus II by several major companies (including Sperry, General Electric, Burroughs, and NCR, per your article) shows that when engineers make a thorough examination of the options, they conclude that the Multibus II architecture is the superior direction for 32-bit applications. At the same time, the Multibus I architecture remains today's most popular standard bus architecture, as it has been for more than a decade—and it will grow as the market expands.

Intel is satisfied to rely on its record of quality and consistency.... We feel that your readers deserve the same.

Tom Kinhan
General manager, Multibus II operation
Intel Corp.
Hillsboro, Ore.

Who invented the IC?

To the editor: In his letter, Norman P. Neureiter of Texas Instruments Inc. states "Robert Noyce made independent contributions to the development of IC technology" [*Electronics*, Sept. 23, 1985, p. 74]. This gives the impresssion that Noyce did not invent the IC.

In fact, Geoffrey W. A. Dummer, Harwick Johnson, Ian M. Ross, Jack S. Kilby, and Robert N. Noyce independently invented different kinds of ICs. C. Lester Hogan discussed all but Ross in a March 1977 article in *Interface Age*. He quotes Dummer: "I would have no hesitation in saying that... the real inventors of integrated circuits are Noyce and his dedicated team at Fairchild."

Those wishing to do so may compare the Noyce and Kilby patents (Nos. 2,981,877 and 3,138,743, respectively) with actual semiconductor circuits.

Peyton M. Cole
Director of strategic marketing
Fairchild Camera & Instrument Corp.
Mountain View, Calif.

Not only made in Japan

To the editor: The article on integrated-circuit packaging trends in Japan was informative and interesting [*Electronics*, Nov. 11, 1985, p. 26]. There are a few points regarding plastic pin-grid-array packages that need clarification, however. PGAs manufactured from laminate printed-circuit-board material have been available in the U. S. for at least three years now from several manufacturers. Semiconductor firms here in the U. S., Canada, Europe, and Brazil are all in the process of developing extensive plastic-PGA product lines for their customers. The U. S. semiconductor industry is aggressively developing the technology and is in my opinion ahead of the Japanese in many respects.

Erik E. Holladay
Vice president, marketing
Hestia Technologies
Santa Clara, Calif.

In response: *There was no implication in the article that Japanese packaging techniques were superior to those employed elsewhere.*

University had "First"

To the editor: I should like to make you aware of certain sensitivities that your Technology Newsletter item [*Electronics*, Nov. 11, 1985, p. 11] raised by linking our work to the First silicon compiler. We do not use First, which was developed in the University of Edinburgh. While I think your article brought this fact out toward the end, your use of the name First as if it were our development has caused some anguish with the department of electrical engineering.

David Milne
Managing director
Wolfson Microelectronics Ltd.
Edinburgh, Scotland

Procedural matters

To the editor: Despite what's stated in "A pride of new CPUs runs high-level languages" [*Electronics*, Nov. 25, 1985, p. 58], the only two nonprocedural languages I know of for sure are Smalltalk and Prolog. Forth and Lisp are unquestionably procedural and, as far as I know, so is Ada.

Roy Fultun
Roy Fultun & Associates
Santa Monica, Calif.

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Am29117

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WEEK 11

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Am29PL141

Ease the transition.

No, the big news is how the Am29PL141 makes it easy to get this circuitry into the right state, right away.

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You don't need Karnaugh maps, Boolean equations, or a couple of weeks of design time.

Nor do you need to tear hardware down (or patch it up) to eliminate an unwanted transition. A painless tweaking of microcode does the job instead.

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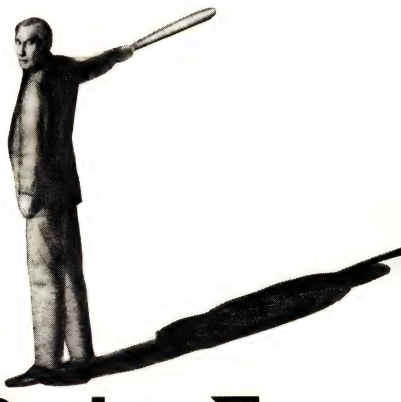

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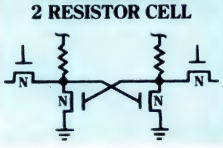

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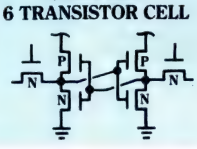

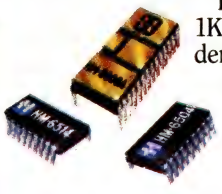

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TECHNOLOGY NEWSLETTER

WOULD YOU BELIEVE A 10-FT-LONG, 550-LB SILICON INGOT?

Single-crystal 6-in. silicon ingots nearly 10 ft long and weighing up to 550 lb could be possible with a new continuous Czochralski growing process being developed at Cybeq Systems, the equipment arm of silicon-wafer maker Siltec Corp. Not merely huge size but high purity is the goal of the process; present batch processes tend to concentrate impurities as the melt diminishes. Controlling purity is the key to making crystals and wafers of uniform resistivity. Cybeq, of Menlo Park, Calif., says the process could cut the cost of wafers by a third and is discussing commercial development of it with several potential partners. Meanwhile, it has joined with the Electric Power Research Institute to improve a batch Czochralski process that would produce high-resistivity (100 to 400 Ω/cm) crystals for power devices. □

TAB MAY BE THE WAY TO GO FOR MULTICHIP VHSIC PACKAGES

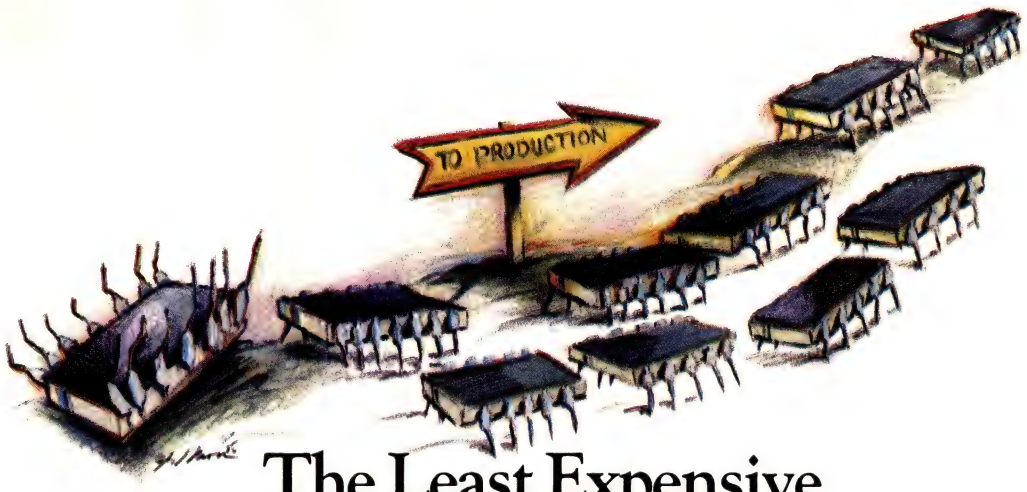
Tape-automated bonding is being investigated as a possible approach to multiple-chip packages for the military's Very High-Speed Integrated Circuits program. The Army's Electronic Research and Development Command in Ft. Monmouth, N. J., has awarded a three-year development contract for VHSIC multichip packaging to a team of Texas Instruments, Interamics, and International Micro Industries researchers. The work will focus partly on multichip TAB technology with two levels of interconnection. One bonding level will be for individual VHSIC components; the other for the ceramic multichip package. "TAB at the chip level will allow complete testing before they are placed in the full-up assembly," says Jesse C. Wilson, manager of TI's Advanced Microelectronics Division in Dallas. The packages will interconnect up to nine circuits and handle both Phase 1 VHSIC chips running at 25 MHz and Phase 2 parts operating at up to 100 MHz. □

ATOMIC BONDING FORMS SEMICONDUCTOR JUNCTIONS

Toshiba Corp. researchers are developing semiconductor junctions formed by atomic bonding of two separate wafers to both speed the fabrication and improve the performance of high-voltage high-current power devices. Two partially processed wafers become one in a two-hour process that includes cleaning and heating to 1,000°C but requires no pressure. Takeshi Ozeki, manager of Toshiba's Electron Devices Laboratory in Kawasaki, says the company will start sales of commercial devices in less than a year. First devices are expected to be bipolar-mode FETs, and power transistors with on-chip logic that is dielectrically isolated from the power transistor. Devices made by the new process will feature higher voltage ratings and operate at higher frequencies than those made by conventional processes. □

NEW CLASS OF FET USES AN ORGANIC-CRYSTAL INSULATION LAYER

A new class of device may be in the wings for future military and commercial semiconductor use. Researchers at Case Western Reserve University in Cleveland have replaced the silicon oxide insulating layer in a FET with an organic crystalline material built up with layers of Langmuir films. The result is an MLS FET, for metal Langmuir semiconductor FET. Recently, the school's Polymer Microdevice Laboratory processed about 400 of the devices on a 2-in. silicon wafer using techniques that are compatible with today's conventional silicon batch-processing methods. The MLS FETs exhibit essentially the same electrical characteristics as conventional FETs, says Scott E. Rickert, the lab's codirector. Their advantages include potentially faster and simpler processing that eliminates the furnace step required for the silicon oxide layer, as well as lower weight. □



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ELECTRONICS NEWSLETTER

GE PONDERS HOW TO MESH RCA INTO ITS OPERATIONS

General Electric Co. and RCA Corp. haven't yet worked out how their merged company will look, but their top officials are convinced they will wind up with an imposing competitor in world markets. Commenting on GE's $6.3 billion purchase of RCA last week, both GE chairman John F. Welch Jr. and RCA president Robert R. Frederick emphasized that the two firms are just beginning to figure out how to fold RCA's businesses into those of GE. RCA, which had 1984 revenue of $10.1 billion, has restructured itself recently into three areas: electronics, communications, and entertainment. Welch noted that RCA's strengths in the military market, such as radar and satellite systems, as well as in the communications and services markets, will complement GE's operations, now running at $28 billion a year. "We think the synergy is great," said Welch, who expects that GE will not have to divest any operations—even in its military businesses—to meet antitrust objections of the government. RCA chairman Thornton F. Bradshaw said the two companies had talked with some high government officials about the merger and had received "encouragement" for the effort. He would not name the government officials.

Welch declined to say what might happen with RCA's Solid State Division or RCA's research laboratories. Wall Street analysts, however, expect GE to shore up RCA's research labs in Princeton, and they expect a restructuring of RCA's chip business. As for consumer electronics, "We have two strong brands, and we will try to develop a strategy to deal with" the overlap, Welch said. It's too early to tell, he said, whether there will be any change in GE's purchases of TV sets and video cassette recorders from Matsushita. RCA makes TV sets and buys VCRs from Hitachi.

Under the deal, GE will pay $66.50 for each of the 94.4 million outstanding RCA shares. The acquisition, though the largest one involving non-oil companies, is a bargain for GE, Wall Street sources said. They figure RCA's stock was worth between $60 and $90 a share. Welch said GE will probably have to borrow $4 billion to $5 billion to fund the acquisition. □

BIG FOUR IN EUROPEAN TELECOM WIDEN COOPERATIVE EFFORTS

The four leading telecommunications equipment makers in the European Community are extending their cooperation in public-switching technology to software-development tools, subscriber-line interfaces for integrated services digital networks, and certain aspects of integrated broadband communications networks of the mid-1990s. Already, West Germany's Siemens, France's CIT-Alcatel, Italy's Italtel, and Great Britain's Plessey are working on standards and specifications that allow the use of common VLSI telecom chips in the companies' latest-generation digital switches: CIT-Alcatel's E10, Italtel's UT10, Plessey's System X, and Siemens's EWSD. □

DORNIER PROPOSES FOUR HIGH-TECH PROJECTS TO EUREKA

Development of fire-fighting robots with artificial intelligence is one of a quartet of projects proposed by Dornier System GmbH for Eureka, Europe's high-technology initiative [*Electronics*, Dec. 2, 1985, p. 53]. Along with the AI robots, the Friedrichshafen subsidiary of West German aerospace company Dornier GmbH has proposed a project for nondestructive testing of materials by neutron radiology. Another project aims at the construction of a free-electron laser, which would be a high-performance laser of very high energy density and variable wavelength—from ultraviolet to extreme infrared. Finally, together with Aeritalia, Dornier wants to develop a 20-ton amphibious aircraft. The proposed robot project would include French, Spanish, and Swiss partners; Dornier is still looking for partners for the laser and neutron-radiology projects. □

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DT1402-F	High Speed	32 SE/16 DI	12	125	–	–	–	16	Yes
DT1405	Low Level	32 SE/16 DI	12-16	0.16-6.7	2	12	50	16	Yes
DT1408	Simultaneous S/H	4SE	12	100	2	12	50	16	Yes
DT1406-8V	Voltage Output	–	–	–	8	12	125	–	–
DT1406-8M	Current Output	–	–	–	8	12	28.5	–	–
DT1406-8CL	Current Loop	–	–	–	8	12	28.5	–	–
DT1403	High Resolution	–	–	–	2 or 4	16	100	–	–
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PRODUCTS NEWSLETTER

SYTEK NETWORK MIXES SYNCHRONOUS AND ASYNCHRONOUS TERMINALS

A single work station can communicate either synchronously within IBM Corp. environments or asynchronously within ASCII environments through a family of local-area-network products. The System 3000, to be introduced this week by Sytek Inc., links ASCII terminals to IBM 3270 cluster controllers and 3270 terminals to ASCII hosts (such as computers from Digital Equipment Corp.) over the Mountain View, Calif., company's proprietary LocalNet 20 broadband LAN. A lower-cost family, the System 7000, is for networks linking only IBM computers. Available next month, both families contain controller interfaces priced at $1,850 and terminal interfaces priced at $1,600. □

TI'S PALETTE CHIP OFFERS 16 COLORS PER LINE OF DISPLAY

A graphics chip from Texas Instruments Inc. can supply 16 different colors for each line of a bit-mapped graphics-display system. The TMS34070 provides the colors from its palette of 4,096 colors. The 22-pin chip, which is being introduced this week, contains on-board digital-to-analog converters to directly drive the red, green, and blue inputs of video monitors. A lookup table allows software to change the group of 16 colors line by line for greater display capabilities. Colors are selected by a 4-bit word. In 100-piece quantities, the 36-MHz 34070 costs $24 each and a 20-MHz version sells for $16.40 each. □

BURROUGHS EASES DATA TRANSFER BETWEEN MINIS AND MAINFRAMES

Users of Burroughs Corp. minicomputers and mainframes will have an easier time transferring data between the two classes of machines thanks to an extension of the Detroit company's micro-to-mainframe package, the Data Transfer System (DTS). DTS-2, like the original DTS package introduced last year, supports the company's B20 and B25 microcomputers and A-series mainframes, but also adds the company's V series of minicomputers and its older B1000 mainframes. Also new with DTS-2 is the ability to access data stored in Burroughs' DMS-II data-base-management system. Available now, DTS-2 costs $525 for each of the first 10 interconnected minicomputers and $55 for each additional machine. The mainframe lease charge is $1,500. □

VOICE INPUT COMES TO FUTURENET'S CIRCUIT-DESIGN SYSTEMS

Users of FutureNet Corp.'s Dash family of work stations can throw away their mice and cursors. The company has signed an agreement with Kurzweil Applied Intelligence Inc., Waltham, Mass., which will furnish speech-recognition peripherals for the Chatsworth, Calif., manufacturer's line of engineering work stations. Available now, voice input adds $6,500 to the cost of the Dash systems, which are based on the IBM Personal Computer. □

CARD ENABLES IBM PC AT TO HANDLE MINICOMPUTER APPLICATIONS

A data-acquisition card for the IBM Corp. Personal Computer AT that samples at 130 kHz will open up applications areas that were previously limited to minicomputers. Data Translation Inc., Marlboro, Mass., envisions such applications for the DT2821-F as vibration and waveform analysis as well as advanced biomedical research. The card is almost three times faster than any product currently available and at $1,595, costs just $12 per kilohertz of processing speed. The nearest competitor is a 50-kHz card from Metrabyte Corp. that costs $20/kHz. The DT2821-F uses two digital-to-analog converters and provides 12-bit resolution on 16 single-ended or 8 differential analog inputs. Delivery takes about five days. □

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Electronics

'FIFTH-GENERATION' COMPUTERS MAY SOON BE AVAILABLE IN U.S.

A GROWING MOVE TO ADD AI PROGRAMMING TO PARALLEL COMPUTERS

BEAVERTON, ORE.

Fifth-generation computers may soon be available in the U. S. In a drive to put artificial intelligence on parallel computers—what the Japanese call the fifth generation—vendors and researchers in the U. S. are looking to AI programming tools for the growing number of parallel computers available here.

Parallel computers can deliver vast amounts of processing power for a reasonable price. And the AI programming needed for more widespread and easier use of computers requires that processing power. The marriage of parallel computers and AI programming tools is stirring up a lot of interest.

The Scientific Computer Division of Intel Corp., Beaverton, makers of the iPSC family of concurrent computers, and Gold Hill Computers Inc., a Cambridge, Mass., AI-software company, last week announced a joint development effort to create a concurrent version of the Common Lisp AI language for the iPSC.

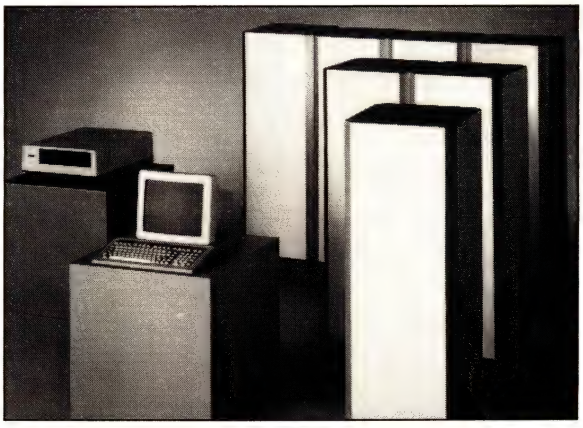
"We were motivated by the large number of people asking about our machine who also expressed an interest in AI," says Charles Bishop, AI program manager at Intel Scientific Computers. "Many have to have both numeric and symbolic [AI] programming to meet the requirements of the government's two major computer-intensive projects: the Strategic Computer Initiative and the Strategic Defense Initiative."

The iPSC parallel computer was introduced in February as a research machine for high-speed numeric processing [*ElectronicsWeek*, Feb. 11, 1985, p. 15]. According to Bishop, more than 25% of the 1,000 or so inquiries indicated a strong interest in symbolic programming.

At Sequent Computers Inc., "a number of the people using and looking at our Balance 8000 parallel computer are expressing an interest in AI programming with both Lisp and Prolog," says chief operating officer Scott Gibson. To meet that demand, Sequent, also of Beaverton, is committed to providing a parallel Lisp language and is holding discussions with possible vendors.

Lisp vendor Lucid Inc., Palo Alto, is another AI-software company looking at the opportunities in parallel AI programming. "We are planning and working on a concurrent Lisp," says chairman and chief executive officer Tony Slocam. He indicates that one of the development projects uses the Q-Lambda approach, which is based on research done at Stanford University by one of Lucid's founders, president and chief technical officer Dick Gabriel. Lucid has been approached by several of the parallel-computer vendors to study their machine architectures with parallel Lisp in mind.

Dallas parallel-computer vendor Flexible Computer Corp. also reports a big interest in parallel AI programming. "We are looking to pick up an available AI language and convert it for concurrent operation on our Flex/32, the way we did with Ada," says Ray Naeini, vice president of software development [*Electronics*, July 15, 1985, p. 59].



PARALLEL AI ENGINE. Intel's iPSC parallel computer is due to have a concurrent version of Common Lisp running on it soon.

MULTILISP. Flexible has not yet purchased a Lisp language, but Naeini says "we are close to a decision." Flexible will start with a commercially available Common Lisp and add multicomputing concepts like those used in Multilisp, a language developed at the Massachusetts Institute of Technology. The company plans to provide a complete AI environment that includes Prolog.

The iPSC version of Gold Hill's Common Lisp, which is expected to be available by mid-1986, may be the first Common Lisp implementation on a parallel computer. Gold Hill has the largest installed base of Lisp users on IBM Corp. Personal Computers and compatibles. One of the reasons Intel chose Gold Hill is its experience with Lisp on the 80286 processor—the processor used in the first iPSC generation.

Gold Hill's Lisp is the only MS-DOS interpreter that runs in protected mode using the full address space of the 286, according to Eugene Wang, vice president of marketing at Gold Hill. The company also sells a Lisp compiler for producing faster programs. Fast processing and large memories both are required for serious AI work.

Intel is also improving performance and memory and adding software to make the iPSC more attractive for AI. In August, the first enhancement to the iPSC, a 4-megabyte memory expansion, was announced.

Intel is now working on a second-generation machine. The current 128-processor iPSC can reach 100 million instructions per second. Preliminary evaluation of the second-generation design indicates that at least two orders of magnitude can be gained, says Bishop.

The second generation will have not only faster processors, but more of them, perhaps up to 1,024. Although Bishop says it is possible to ship such a machine by 1988, Intel is not committing to a target date because it wants to wait long enough to incorporate ideas from the researchers in the more than 12 educational, government, and industrial sites now using the iPSC.

Although the current iPSC and the new concurrent Lisp (when it is available) will provide a research platform for parallel AI, it is the power of the 10,000-mips second-generation machine with extensive AI software support that will make a fifth-generation computer. "When the second-generation hardware is available, then the machine could be

called a fifth-generation computer, but it depends upon the progress made by the researchers," Bishop says.

But Gold Hill's Wang is more ebullient. Referring to the current iPSC with concurrent Common Lisp, he says, "We're talking about a real fifth-generation computer here." *–Tom Manuel*

SEMICONDUCTORS

BELL LABS BUILDS 5.8-ps TRANSISTOR

MURRAY HILL, N. J.

AT&T Bell Laboratories has eclipsed the world speed record for semiconductor devices with a family of compound semiconductors capable of turning on or off in 5.8 ps. That's 32%, or 2.7 ps, faster than the record set last summer by Honeywell Inc. researchers.

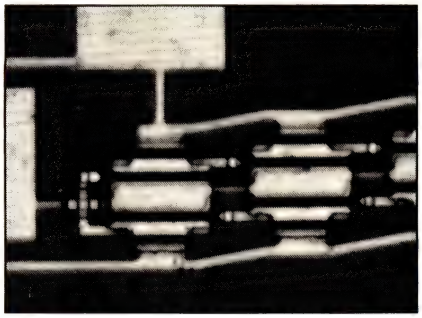
AT&T researchers achieved the results with between 5 and 10 different chips that they call selectively doped heterostructure transistors. All use a wafer structure made up of an ultrathin layer of gallium arsenide beneath a slightly thicker layer of selectively doped aluminum gallium arsenide.

The landmark speed was achieved by cooling the parts in liquid nitrogen to 77 K. But at room temperature, the chips still provide near-record results, with a switching time of 10.2 ps and power use of 1.03 mW per gate (compared with 1.76 mW/gate at 77 K). "We're getting within spitting distance of the real physical limits," says one researcher.

AT&T used molecular-beam epitaxy to grow a 300-Å-thick layer of AlGaAs doped with silicon ions on top of a 100-Å-thick layer of GaAs. Also important is the size of the device's gate, which is only 0.35 μm wide. AT&T called on scientists at the National Research and Resource Facility for Submicron Structures at Cornell University for help in etching the fine features with electron-beam lithography equipment.

But the thin semiconductor layers are what make the device unique. Growing the layers on 2-in. wafers, the MBE system deposits the substances layer by atomic layer, providing the utmost in control. "You have to have a sharp interface between the two layers," says Nitin Shah, one of the three principal researchers working on the project.

The sharp definition provided by selective-doping techniques is essential to separate the impurities in the AlGaAs layer from the free electrons that are attracted to the thin GaAs layer, says Shin Shem Pei, supervisor of Bell Labs' High Speed III-IV Device and IC Group. The electrons can travel quickly in a steady stream away from the impurities, which cause them to scatter and dissipate their speed.



RING IT OUT. GaAs transistors in a Bell Labs ring oscillator switch in 5.8 ps at 77 K.

"MBE makes this device structure possible," says Pei. "The idea was around for 20 years, but no one could do it until recently."

AT&T is not the only one doing work with such structures. Toshiba Corp. and Gould Inc. are both selling discrete high-electron-mobility transistors using similar technology [*Electronics*, Dec. 9, 1985, p. 18]. But AT&T's interest is in integrated circuits, Shah emphasizes, and thus direct comparisons are misleading.

REALISTIC APPLICATIONS. The AT&T researchers maintain that their prototype parts are not just laboratory freaks without real-world applications. Their work has provided a legitimate successor to GaAs metal-semiconductor field-effect transistors, they say. "This is a realistic application-oriented technology," says Pei. "This is the next generation of GaAs devices."

AT&T is aiming the new technology at the high-speed digital IC market, particularly microprocessors, telecommunications, and memory, where low power and high speed are essential. Although the initial chips, which include ring oscillators and frequency dividers, represent only small-scale integration, Pei says, large- and very-large-scale ICs are conceivable. AT&T has no commercial products in mind now, but plans are in place to make "devices for internal experimentation and evaluation," he says.

The work was a collaborative effort between AT&T and Cornell University and was paid for in part by government grants. *–Tobias Naegele*

BUSINESS

ARE DISTRIBUTORS SIGNALING UPTURN?

LOS ANGELES

If electronic-components distributors really are a bellwether for semiconductor sales, as many savvy industry watchers maintain, then better times could soon be here for the gloom-struck chip business.

Several distributors now report a "perceptible but not dramatic" upturn, as one official put it, that has been under way since early October. This upswing, the first since the downslide began in mid-1984, centers in the western U. S., where changing prospects for semiconductors often show up first.

An upswing at distributors after a prolonged recession has particular significance for the industry: in the past, such changes have foreshadowed a turnaround at semiconductor manufacturers by about six months (chart). The pattern starts with small customers buying in small quantities from nearby distribution outlets. Then larger companies jump in, first purchasing from distributors, later going directly to vendors as quantities grow. Orders soon overwhelm stock, causing production increases across the board.

But old hands in the industry question whether a distribution trend of only several months signals a turnaround. "It might be a flash in the pan similar to the false start in 1982 from February to May," warns Jack Beedle, president and founder of In-Stat Inc., a market-analysis company in Scottsdale, Ariz. That upturn "died a horrible death" when big orders did not follow.

Clearly signaling at least temporary improvement, however, is Wyle Laboratories Inc., with distribution operations serving 13 western states. The El Segundo, Calif., company reported that for the third quarter, which ended Oct. 31, its Electronics Marketing Group went into the black after months of losses, with $922,000 more operating income than in the second quarter. The $545,000 operating income from distribution operations, compared with $3.2 million for the same quarter last year, shows how hard the decline hit Wyle.

The upturn stayed on course in November with an 8% gain over October, even with fewer working days, says president Charles M. Clough. He predicts conditions will improve so steadily for recession-racked semiconductors that by spring a strong turnaround could spur U. S. growth of 20% to 23% for the whole year.

Clough's peers hope he's right, and many cautiously confirm they've seen the beginnings of an upswing. "It's encouraging," says Howard B. Franklin,

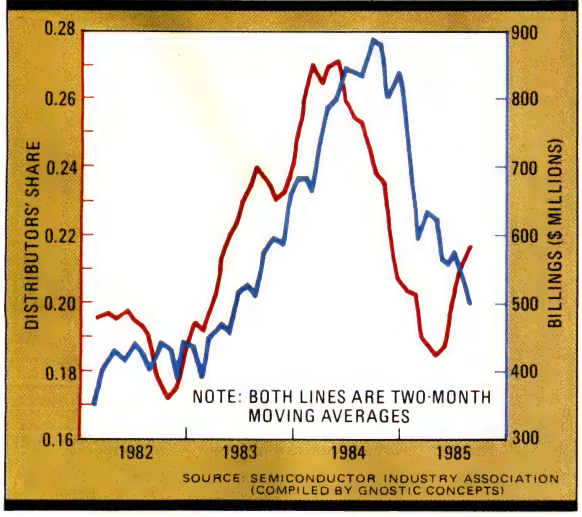
senior vice president in charge of the Western-oriented Electronics Group of Bell Industries Inc., Los Angeles. "Everyone believes things are turning around, but the real effects won't be until the second quarter."

"There has been a small, though not dramatic, steady increase of orders activity since August," notes Bruno Pagliuca, vice president and director of worldwide semiconductor marketing for Texas Instruments Inc. in Dallas.

At nationwide distributor Schweber Electronics, Westbury, N. Y., executive vice president Robert E. Johnson notes "a pickup beginning on the West Coast." But any movement in the overall depressed pattern is still slight, he concedes.

Arrow Electronics Inc., New York, has had more orders each month since July, when business hit bottom, according to president Stephen P. Kaufman. Because shipments lag orders by two to three months, improved financial results are just starting to appear, he says.

IC BILLINGS SHADOW DISTRIBUTORS' MARKET SHARE



In Clough's view, the distribution recovery rests on solid underpinnings. Inventories of parts stocked by the best customers, small- to medium-size companies in the under-$100 million category, are down sharply from the bloated levels that kept them out of the market for a year. Wyle tracks these customers through 31 key accounts in which inventories have dropped 34% since January. Pronounces Clough: "This inventory glut is surely over."

But the Wyle executive, along with others, draws a clear distinction between these happier prospects and the continuing oversupply of parts still held by the biggest original-equipment manufacturers, mostly computer companies. During the boom of 1983-84, they stockpiled parts against predicted shortages, then had to swallow them when demand dried up.

STILL OVERSTOCKED. Components are still overstocked on many distributors' shelves, particularly at the largest companies, which could not cut back as fast as smaller, regional competitors could, sources say. Both Clough and Bell Industries' Franklin agree that it will take at least until March to pare these levels to the point at which heavyweight companies start to buy again, triggering orders to semiconductor manufacturers. By May or June, Clough believes, a strong recovery will be under way.

But Clough's stance—especially his forecast of 20% to 23% growth, which is far rosier than consensus estimates of limited growth next year—finds scant support among most battle-scarred distributors. A typical response comes from Arrow's Kaufman: "Any improvement will be gradual."

Doubts abound in financial circles, too, although Wyle common stock took

GNOSTIC SEES A BETTER WAY TO FORECAST IC DEMAND

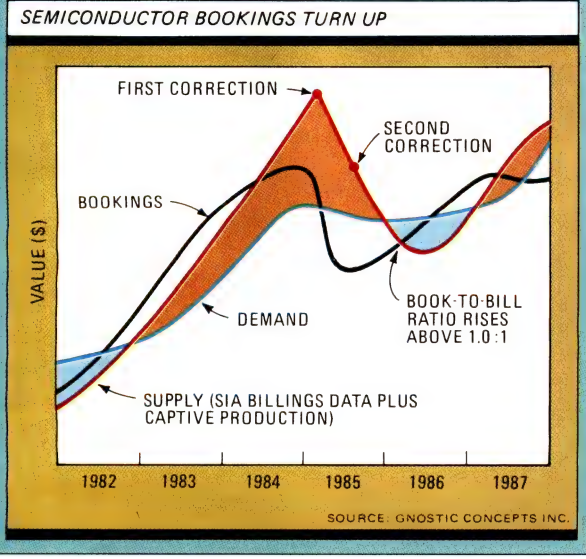
The book-to-bill ratio is a handy tool for tracking the semiconductor industry's fortunes, but it has the drawback of being extremely volatile. If users think supply will be limited, they overbook; then, when supply increases to meet the inflated predictions, bookings drop to nearly nothing.

A forecasting tool developed by Gnostic Concepts Inc., a San Mateo, Calif., market-research subsidiary of McGraw-Hill Inc., measures billings against a demand forecast. Gnostic says the tool, called SIFT (for semiconductor industry forecasting and tracking), thus obtains a measure of user inventories, a key element in determining when an increase in demand really requires an increase in supply.

SIFT determines U. S. integrated-circuit production by adding the billings data supplied by the Semiconductor Industry Association to Gnostic's own data on captive production. Demand is more difficult to peg. Gnostic derives it from macroeconomic factors that determine the production of electronic equipment. Equipment figures are then analyzed using the input/output models developed by Nobel laureate Wassily Leontief, by which component requirements can be calculated as a percentage of equipment costs.

Armed with these numbers, Gnostic can then chart inventory growth and shrinkage as the area between the production and consumption curves. This is the shaded area in the diagram. (The chart does not show absolute values, and the shaded area's size has been exaggerated to highlight what happened in the current semiconductor slump.)

SEMICONDUCTOR BOOKINGS TURN UP



The bookings curve shows that inventories were already building up when the book-to-bill ratio fell below 1 in September 1984. The supply could not be turned off quickly, however, and it took two corrections to sop up all the excess inventory.

According to Gnostic's model, the ratio will climb past 1 early in 1986 and remain there all year. Billings won't increase much until late in the year. (The SIA last week released figures showing that the ratio rose in November for the second straight month, to 0.90.)

Gnostic's model has 170 macroeconomic factors: gross national product, value of the dollar, and so on. It measures 400 equipment sectors and 500 linear, digital, and discrete components, giving 20,000 component data points.

Gnostic research director Terry Wong concedes that the consumption data is less reliable the farther it gets from the basic macroeconomic assumptions. The figures are revised quarterly. But Gnostic does claim that its figures for captive production are accurate. They are obtained the hard way—through interviews and careful estimates. "We have a lot of captive clients and they've never taken us to task for our numbers," Wong says. *–Clifford Barney*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Part number	EEPROM bytes	User ROM bytes	RAM bytes
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MC68HC11D4	512	4K	256
MC68HC811A2	2K	—	256
MC68HC811D4	4K	—	256
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Four K of E^2PROM makes the MC68HC805C4 perfect for design improvements in automotive applications, telecommunications, robotics, industrial control, and so on and so on. Use it for emulating dynamically reprogrammable mask-ROM based MCUs and peripheral processors. Complete end-product updates, variations and changes with software alone.

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off in advance of the company's appearance Dec. 4 before New York financial analysts, where Clough made his views known. James Barlage of New York's Smith Barney, Harris Upham & Co., for example, questions Clough's timetable. "Only 75% of the inventory has been worked off," he estimates. But Barlage concedes Clough "is on solid ground, though more positive than I am."

According to analyst James Jeffs of Los Angeles' Siedler Amdec Securities Inc., the improvement for distributors in the past few months is only "a lot of pipeline filling, not at the OEM level yet." *–Larry Waller*

VACUUM DEVICES

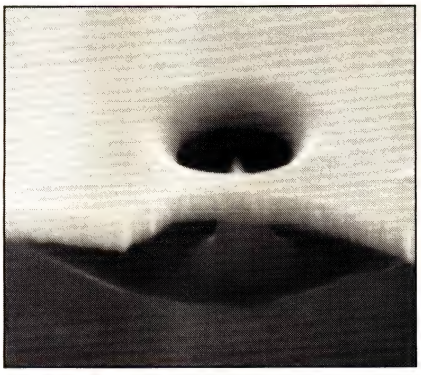
'VACUUM ICs' WOULD BE FAST AND HEAT RESISTANT

WASHINGTON

Fabrication and processing technologies developed over the past 20 years for integrated circuits can make electron-tube devices as small as transistors and with comparable levels of integration, say researchers at the Naval Research Laboratory. What's more, they say these 'vacuum ICs' could provide subpicosecond transit times for very fast real-time signal and data processing, temperature insensitivity, and improved radiation hardness for space applications.

In a paper delivered at the International Electron Devices Meeting in early December, NRL researchers Richard Greene, Henry Gray, and George Campisi described two approaches to vacuum ICs: thermionic triodes being fabricated at Los Alamos National Laboratories and field-emitter vacuum ICs under development at the NRL, SRI International, and elsewhere. The NRL researchers view the latter as the more difficult approach, but one that could yield submicron devices operating at 100-fs speeds. The field-emitter research could also find its way into the Strategic Defense Initiative (SDI).

Field-emitter array technology has been under development at SRI for more than 10 years, according to C. A. Spindt, a senior research engineer at the Menlo Park, Calif., company. "We feel that we're very close" to commercial applications, he says. SRI's field-emitter cathode structures are arrays of refractory-metal emitters shaped by evaporation into sharp points as narrow as 0.03 μm. The emitter tips point into holes formed lithographically in a metal layer. The holes can be less than 1 μm across.



CATHODE. Thin-film field-emission cathodes with 0.03-μm tips have been built by SRI International for silicon-chip vacuum devices.

NRL uses more conventional silicon-processing technologies such as electron-beam lithography and orientation-dependent etching to produce self-aligned emitters with insulated grids, says Greene, who heads the NRL's surface-physics branch. "If vacuum devices can be practically fabricated at the micron level, transit times below 1 ps can be achieved, particularly in FE structures where the additional advantages of very high fields at the emitter occur."

The field-emitter approach requires high voltages (100 V on the grid and 200 to 500 V on the anode) and, like the thermionic approach, may use orders of magnitude more power than do transistors. But unlike transistors, the vacuum devices thrive in the heat they create.

Field-emitter research remains a long-range, high-risk program, however, that will require improvements in processing and fabrication techniques, says Greene. Production of NRL's device remains at least 10 years away.

THERMIONIC ICs. Meanwhile, Los Alamos researchers have been fabricating thermionic ICs, which operate at over 800°C, by depositing cathode, grid, and anode materials on sapphire substrates using optical lithography. Small-scale integration for flip-flops and power supplies have been demonstrated as work proceeds on device-stacking methods. Greene says thermionic chips could operate in the low-gigahertz range.

Spindt and Greene acknowledge that their research could have applications within SDI. Along with the improved radiation hardening for space-based systems, techniques such as submicron three-dimensional machining could be used to develop cathodes for free-electron lasers. SDI officials recently mentioned land-based free-electron lasers as a likely focus of research because of their energy efficiency and concentrated beam. *–George Leopold*

ARTIFICIAL INTELLIGENCE

AT&T BUILDS FUZZY-INFERENCE CHIP

HOLMDEL, N. J.

A single chip that is an incredible 100,000 times faster than conventional hardware could help designers get around the barriers to the integration of expert systems and robots. Up to now, integrating the two technologies has been nearly impossible: designers have found conventional hardware and specially written expert-system software too cumbersome and slow to process data for the motion-control functions that sophisticated robots require.

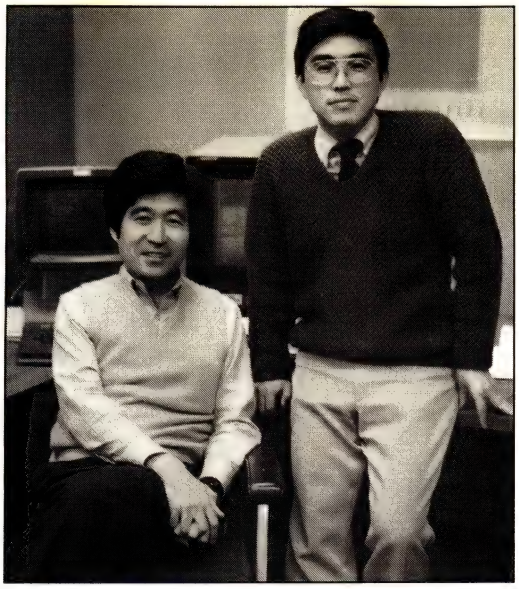
Researchers at AT&T Bell Laboratories believe they have licked that problem by using fuzzy logic, the logic of approximate reasoning. Their CMOS circuit performed 80,000 inferences/s when tested with a two-phase 20.8-MHz clock that provided a 48-ns clock cycle. Simulations indicate it can run at even higher speeds, according to Masaki Togai, who designed the inference engine on the prototype chip.

Prototypes of the 6-by-6-mm CMOS chip have been produced using 2.5-μm geometries and providing circuitry for 16 fuzzy sets, or rules. Although they say 16 rules are sufficient for many if not most tasks, Togai and Hiroyuki Watanabe, who designed the circuit, acknowledge that the prototype uses only about 25% of the chip's 2.99-by-3.58-mm active area.

"We implemented 16 rules on the chip and we've found we can put more rules on by using smaller geometries in design," says Watanabe, who worked for three months on the chip's design. "In the prototype, we were conservative. We just wanted to see if it would work." Togai says up to 128 inference rules could be etched in silicon by cutting the chip's minimum feature size in half, to 1.25 μm, and adjusting some of the internal circuitry.

SIMPLE AS POSSIBLE. Designed to be as simple as possible, the chip consists of two rule-set memories—one for storing the antecedent or question in each rule, and one to store the conclusion; a con-

INFERENCE ENGINEERS. Bell Labs' Watanabe and Togai have built an IC that makes fuzzy-logic inferences.



troller to oversee the movement of data throughout the chip; and the inference-processing unit, designed as a folded binary tree to keep it small.

"It's a very simple cell," says Watanabe. "It doesn't take up much space."

Togai says he tested the fuzzy-logic algorithms that he developed for the chip on a Digital Equipment Corp. VAX computer and was unable to come within a fraction of the processing speed the chip is capable of. "Roughly speaking," he says, "we have reached speeds 100,000 times faster than if we used a conventional [hardware] approach."

That speed is made possible, Togai and Watanabe say, by locating the rule-set memory on the chip. That permits the inference engine to process all the rules in parallel. If the rule sets are stored off the chip, they say, the available pin count prevents the effective use of parallelism, slowing down the processing speed.

Speed matters in applications such as command and control of missiles and robots—the areas that interest the two researchers. Togai says robots require decision outputs every 20 to 100 ms, and guidance systems could require even faster results. Togai and Watanabe plan to build a coprocessor board around the chip that can be added to a microcomputer to allow it to perform motion control for robots. *–Tobias Naegele*

AI TO HELP MECHANICS AT RENAULT DO A BETTER JOB

PARIS

French automobile owners might soon get faster and more expert repair work, thanks to a move by the country's principal automaker to put an artificial-intelligence system at the service of its mechanics.

The heart of the system is an expert-system software module dedicated to diagnosing the cause of automobile malfunctions. The system was jointly developed by Cap Sogeti Innovation, the research subsidiary of Cap Gemini Sogeti SA, France's largest data-processing service and consulting group, and Régie Renault, the nationalized car maker.

The software comes in a shell program that can be customized by automobile technical experts to deal individually with any of a car's various subsystems. The prototype of the software runs on an IBM Corp. Personal Computer and currently is being used to analyze automatic-transmission breakdowns. In the future, it will be used to aid repairs in other areas that are typically difficult to diagnose, such as on-the-road behavior and electrical faults.

Distribution potential is broad: Renault has some 9,000 dealers scattered throughout France. The initial results of the system's trials have been "extremely impressive," says Gérard Martineau, who is coordinating the project from the Renault research center. Company estimates put the system's ability to solve transmission faults above 99%.

The automatic transmission is the perfect example of the type of diagnosis problem Renault would like to tackle with the system. Because such transmissions are still rare in France, mechanics have little experience working with them. Even simple breakdowns often require the transmission to be sent back to Renault—an expensive, time-consuming operation—simply because the mechanic is unable to diagnose the problem.

THREE MODES. To get around this snag, Renault asked Cap Sogeti to help it find a way of diffusing in-house knowledge of its automatic-transmission systems to the mechanics by using AI. The result is a program that works in three different modes: consultation mode for use by the mechanic; archive mode, in which Renault's after-sales service department can analyze statistics on the types of breakdowns probed and the system's success in detecting them; and an update mode, whereby the software can be adapted to new technical information and products.

Designed to be easy to use in the garage, the system only requires entry of numbers or yes and no answers on the keyboard. After the mechanic enters the model of the car and the number on the plate fixed to the transmission, the system asks him a series of diagnostic questions until it is satisfied that it has detected the type of fault. It then suggests possible remedies and monitors his progress by asking whether a given suggestion has had the desired effect.

Apart from the program's diagnostic framework, the chief difficulty in developing the system was defining the tree-like series of questions an expert technician asks in trying to diagnose a breakdown, points out Pascal Jeambrun, principal engineer for Cap Sogeti Innovation. To do this, the programmers listened in on telephone calls for several months from garage mechanics to technicians at Renault's headquarters.

The prototype versions are installed at two Parisian garages and run on IBM PCs. Future versions will fit into a diagnostic console that is IBM compatible and manufactured for Renault by two compatriot companies, Sagem and Souriau SA. *–Robert T. Gallagher*

AUTOMATIC TEST EQUIPMENT

CAN 'PER-PIN' TESTERS TAKE OVER VLSI BUSINESS?

PALO ALTO

A new generation of automatic test equipment for complex very large-scale integrated circuits is taking off fast. Developers of these systems—called per-pin testers—promise a lot: they claim the testers should drop the cost of testing and boost accuracy and throughput. Manufacturers are counting on this technology and the pressing need to find better ways for testing VLSI chips to help them cut into the market share of traditional ATE players such as GenRad, Sentry Digital Test Systems, and Teradyne.

Digital-test-equipment companies such as Megatest Corp. and Trillium Test Systems, as well as analog-ATE startup Attain Inc., are touting the per-pin systems, which can test components having

256 or more pins at a test rate of 40 MHz. A Japanese player, Ando Electric Co., Tokyo, has such a system for LSI chips. The architecture is expected to garner 30% of a $208 million market for VLSI testers next year, and "almost all" of a $354 million market by 1990, according to market researcher VLSI Research Inc., San Jose, Calif.

The growing popularity of the new architecture has sparked debate in the ATE community about these systems' value in testing low-pin-count parts. But while that point is under contention, the system has already found a market. Megatest and Attain recently made big sales that ordinarily would have gone to bigger, more established test-equipment companies.

Megatest recently sold a MegaOne machine to IBM Corp., which will use it for incoming tests of Intel Corp.'s 80386 microprocessors. Megatest's sale beat out Teradyne Inc., Woodland Hills, Calif., the recognized market leader in ATE. Teradyne would not comment on the IBM sale. It is the only U. S. ATE company not claiming an upcoming per-pin system.

In addition, sources indicate that Megatest recently shipped two MegaOne systems to a major IC manufacturer.

Attain, of Milpitas, Calif., recently installed its Attain 2000 system at Omni Technology Corp., a Fremont, Calif., tester of military-aerospace components. The linear system was chosen over competing systems from GenRad, Sentry, and Teradyne.

"Next-generation choices are being made now," says Steve Bisset, founder and president of Megatest, San Jose, Calif. Last February, the 10-year veteran of ATE became the first company to design and sell a per-pin system. "In the past nine months, capacity-driven expansion [by IC companies] has stopped. The momentum has gone."

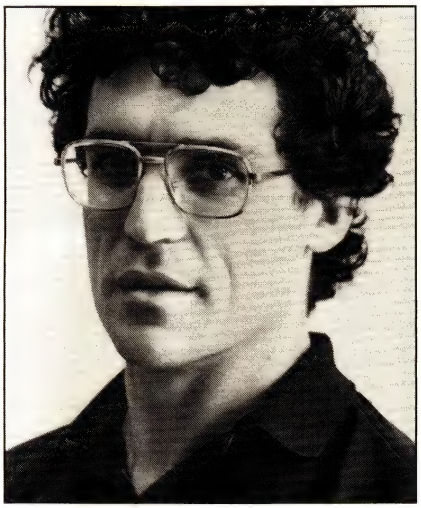
SLUMP HAS HELPED. Jim Healy, president of Trillium, agrees. He says the semiconductor industry slump has actually helped companies such as his own—a Santa Clara, Calif., subsidiary of LTX Corp.—and Megatest. "So far, all six of the systems we've sold have been to semiconductor manufacturers. That's because the only people spending money right now are research and development people," he says.

The tester-per-pin concept is not new, though each vendor implements it differently and is at a different stage in its development program. In its most basic form, each pin site for a complex IC—up to 256 pins—is tested with the appropriate test hardware instead of having the component pins share that hardware through highly complex software.

Which test functions are designated per-pin—such as pattern generation, voltage levels, and parametric measuring—is up to the vendor. Bisset believes putting a timing generator at each pin site is a prerequisite.

One benefit of such systems is modularity—the ability to configure the machine to test anything from 16 to 256 pins and up without having to change test software.

"The idea of such an architecture has been around for a long time, because it is so elegant—one timing generator per one pin electronics," says Bisset. "But to get the cost of the timing generators down, we needed breakthroughs and that is our proprietary technology, not the idea itself."



CHOOSE NOW. Megatest's Bisset says next-generation choices are being made now.

Market analyst G. Dan Hutcheson, of VLSI Research, believes Megatest and other companies offering per-pin systems are on the right track. "It is unquestionable that per-pin architecture is the next generation," he says. "People think it's too expensive, but in the intermediate [pin-count] ranges, it decreases the cost of testing because it allows you to increase throughput."

But unlike Bisset and other per-pin-systems vendors, Hutcheson doesn't believe the technology will cross the barrier from more specialized high-pin-count testing to low-pin-count production lines. "Dedicated systems are much more economical," he claims.

ATE companies such as GenRad and Sentry agree with Hutcheson. "There is a very strong demand in the market to produce production testers which do not cost $2 million to $3 million per copy," says Fred Laccabue, vice president for sales at Sentry, a Schlumberger Ltd. subsidiary in San Jose. "Though per-pin architecture is already in the current generation of testers, sharing and multiplexing timing generators to the pins is one method to accommodate the need for lower cost."

Eugene P. Roth, director of marketing for GenRad Semiconductor Test Inc., Milpitas, concurs. "I think per-pin is appropriate for engineering environments, in a cost sense. The GR18 [GenRad's per-pin system] is twice as expensive as the GR16," he says. "The point is, if you put a single [parametric measuring unit] per pin, you're replicating functions over a number of pins and you just can't avoid that expense."

Ando Electric, which expects its system to become the method of choice for high-speed dc tests on random-logic high-pin-count parts, does not see it as a replacement for current ATE designs for low-pin-count chips.

But despite such caveats, Hutcheson sees a big future for the systems. The 1984 market for complex-VLSI testers was $78 million, he says, and per-pin systems had not yet begun to ship. In 1985, the market jumped to $134.4 million and per-pin systems already account for $22 million in sales—an instant 16% of the market.

"By 1990, the total market for complex VLSI testers will be $354 million," says Hutcheson. "We think by then almost all complex-VLSI testers will be tester-per-pin architectures. Megatest has certainly done the right thing in the right market. Now it just remains to be seen if they can capitalize on being the pioneer." *–Denise Caruso*

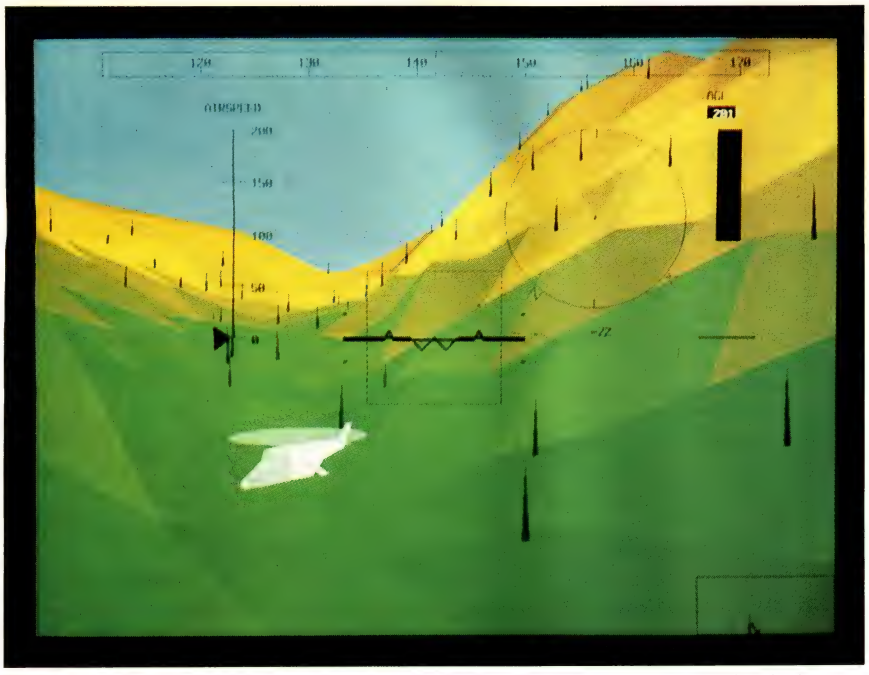
MILITARY

A CHEAPER WAY TO LEARN IF AVIONICS GEAR WILL FLY

DALLAS

Military avionics developers can now find out much earlier and at far less cost whether their designs will fly. An interactive work station will enable them to assess better the effectiveness of cockpit displays, flight controls, weapons, and sensors. Their better view of design performance comes from the marriage of commercially available graphics engines and classified digital terrain data from the U. S. Defense Mapping Agency.

The work station is being integrated for nearly a half-dozen defense contractors and government agencies by Merit Technology Inc. The Dallas startup originally intended to use the simulation tools in its own engineering consulting business, but once aircraft manufactur-



ENEMY COPTER. Imaps overlays a head-up display in a flight simulated for avionics designers.

ers got wind of the system, it quickly became a big seller. Merit is also expanding the scope of the system to address development of future ground-based vehicles as well as information-intensive command, control, communications, and intelligence systems.

Merit's Interactive Mission Analysis Planning Station, or Imaps, can be configured to include a host minicomputer, optional artificial-intelligence systems, hardware for manned simulation, and graphics hardware from Silicon Graphics Inc. The system can be used to analyze pilot reactions and system performance during real-time simulated missions with displays that show terrain. Users can also program enemy aircraft, ground threats, weather conditions, and head-up displays into the scene.

FUTURE AI USE. In the future, Merit officials believe, Imaps could lead the way to preflight briefing stations for aircraft expert systems or provide automated combat rehearsals for pilots. Mission planners could use similar interactive graphics work stations to program AI-based avionics. Jet-fighter pilots could then practice mission routes using the same data base, simulating low-altitude flight over identified threats scattered across the terrain.

But the current market window for the moderately priced planning stations is for engineering. Defense contractors are developing tactical fighters and advanced helicopters that will incorporate new electronics and software systems. "All of these [programs] are in the conceptual phase of defining the avionics suites, the AI-based interactive systems with pilots, and just how much software will automate these systems," says engineering vice-president Ken Pedersen.

"Moderately priced commercial graphics units have become powerful enough to handle out-the-window display for man-in-the-loop simulations," adds Pedersen. Basic hardware for Imaps costs about $100,000, compared with millions of dollars for larger mainframe-based flight simulators. Software will run between $50,000 and $500,000, depending on the scope of simulation packages.

Imaps was designed in modular blocks for expansion and modification. Expansions can include AI-oriented hardware as well as Lisp-based expert systems and analysis packages to grade algorithms for ground-following trajectories, threat assessment, weapons control, radar, and mission tactics. In many cases, accurately represented terrain data is needed to analyze performance of interactive algorithms that play off the profile of the land. Therefore, Imaps uses digital terrain-elevation and feature-analysis data without conversion. Data from either the Defense Mapping Agency or the U. S. Geological Survey is used.

Terrain displays represent land and water as shaded polygons; color shading indicates changes in elevation. The system uses the same terrain data base to display map-like straight-down views; straight-ahead views; or "omni" views (tilted, three-dimensional representations). Plan and omni views are normally used in premission planning and postflight analysis.

The straight-ahead display is used in real-time manned simulations. Nonreal-time simulations may also be used when modeling complex radar systems and other avionics. Meanwhile, the host computer logs quantitative records of system performance, mission successes, and survival chances.

"The system provides avionics engineers both qualitative and quantitative measurements," says G. Mel Barney, vice president of marketing. "Qualitative measurements are important because design engineers, sitting in their offices, cannot get a feel for what the pilots will see. This may help determine the best location of a [head-up] display or whether an alarm is better than a visual indicator." *–J. Robert Lineback*

BIOMEDICINE

IMPLANTED 'SMART' PROBE RELAYS NERVE IMPULSES

BOSTON

Work on chips that can detect nerve impulses has taken a leap forward with the fabrication of tiny "smart" silicon probes. Under development by a team at the University of Michigan, the probe arrays have on-board circuitry for amplification, multiplexing, and self-testing.

These new chips and less-sophisticated implant devices developed at the Massachusetts Institute of Technology are important tools in learning more about how neurons are linked in circuits and how they process information. Much farther down the road, such devices may also be used in closed-loop prosthetic devices.

The work at the University of Michigan focuses on probes for the central nervous system. In Cambridge, Mass., researchers at MIT are working on electrodes that can pick up the impulses generated by peripheral nerves. The goal there is to develop prosthetic devices for amputees.

In both cases, the development of implantable chips involves special challenges. For one thing, implants into living bodies are submerged in saline body fluids, which means designers must select a passivation layer compatible with semiconductor processes. For another, pulses generated by neurons are typically in the range of 50 to 150 μV and lead impedance is on the order of 10 MΩ, making the chips sensitive to leakage.

"The only way to get signals out in the long term is to bring electronics into the probe structure, so you have both

NERVE SENSOR. An implantable silicon probe chip fabricated by a team from the Univeristy of Michigan detects the firing of a single neuron.

amplification and buffering to drive [signals] off chip," says Kensall Wise, professor of electrical and computer engineering at the University of Michigan, who worked with Khalil Najafi and Kenneth Drake to develop the probes.

PASSIVATION PROGRAM. The probes are roughly key-shaped (see photo), with shanks 10 to 15 μm thick. They are fabricated using a four-mask single-sided process on wafers of standard thickness. An etch solution chemically dissolves the wafer material to form the probes, and boron is required as a barrier to that solution. But the very high boron doping complicates the placement of circuitry.

To get around the problem, the team at Michigan boron-doped only the perimeter of the rear portion of the silicon probe, which left the center portion's resistivity unaltered. Polyimide and parylene coatings protect the circuitry from saline solution. The recording sites in the array have gold inlaid over tantalum or polysilicon interconnections.

The on-board MOS FET circuitry includes 10 channels of amplification, each with a gain of 100. Outputs are multiplexed onto a common data line using an analog multiplexer and broadband output buffer. Clock frequency is 200 kHz, providing a per-channel bandwidth of 6 kHz.

The on-chip circuitry also allows impedance levels to be tested *in vivo*. Pulsing the power-supply line with 5 to 8 V latches the test-enable circuit into the test mode and sends 1-kHz signals to the input lines. The signals are amplified and multiplexed for output and thus provide an external indication of the electrode's impedance levels.

Power dissipation for the on-board circuitry is 5 mW at 5 V, with an active area about 1.3 mm^2. The chip design is based on a double-polysilicon triply implanted enhancement- and depletion-mode n-MOS process using 6-μm features.

At MIT, researchers use grid-like silicon structures to make intimate contact with the severed peripheral nerves of laboratory animals. David Edell, an assistant professor in the Harvard-MIT division of Health Sciences and Technology and the department of electrical engineering at MIT, says the goal is to develop within five years a "simple, crude" binary data system of use to amputees.

Perhaps MIT's biggest accomplishment to date has been that interfaces between nerves and silicon have been achieved without damaging the nerves. More work is needed to find passivation that would last for a human lifetime so the chips would be appropriate for long-term implants. The MIT group is working on ways to determine the effectiveness of such coatings.

In the area of electrode design, MIT researchers reduced size to improve selectivity but then had to deal with problems of impedance and noise. Now they are using sputtering and electroplating techniques to roughen the electrode surfaces (to increase the surface area of the sensitive region) and for characterization purposes.

Edell says work on peripheral nerves is somewhat simpler than that in the central nervous system. "We're interested in detecting the neural information itself—the action potential" that normally causes a muscle to twitch—"and if you've determined whether the action potential occurs, you've determined all the information."

Detecting action potentials requires a lot less data than analyzing neural activity in the brain. Edell believes data from a severed peripheral nerve could be gathered at 100-Hz sampling rates. "The more we can simplify the electronic signal by electrode design, the simpler detection circuitry will be." He adds that, in the near future, the group will gather human-nerve data through noninvasive techniques. *–Craig D. Rose*

COMPUTER-AIDED DESIGN

CAD SYSTEM TURNS OUT DENTURES IN 30 MINUTES

PARIS

A computer-controlled system that cuts dentures to measure, and in far less time than conventional methods, could ease that lengthy and uncomfortable process. François Duret, who practices dental surgery in Grenoble, put the system together after 15 years of research into computer-aided design.

Using a microcomputer-controlled optical probe of Duret's design, the system translates the three-dimensional form of a patient's mouth into digital information, which the computer then uses to drive a high-precision machine tool to cut dentures. The entire operation takes less than 30 min.

Duret estimates his system can double or triple a dentist's productivity in such operations, at the same time making the procedure easier for the patient. According to Duret, the patient gets a better-fitting denture and gets it immediately: the wait for a handcrafted denture can often take weeks. In addition, Duret's system nearly eliminates the need for adjustments, which Duret believes are the most tedious part of the denture-fitting process.

But the operation is also painless in the economic sense. Duret is convinced that his system will be able to use materials far less expensive than the high-quality porcelain currently standard for an aesthetically pleasing denture and that the cost of the operation for the patient will thus drop significantly.

Hardware for Duret's system consists of a Digital Equipment Corp. MicroVAX II, the optical probe, and a micromilling machine. There are two software modules—one for processing the probe's output signal, and the other for 3-d modeling of the data.

Duret will give few details on the probe, but says it consists principally of a laser-diode source and a charge-coupled-device photoreceptor. After a nonreflective substance is applied to the patient's teeth to eliminate spurious reflections, the probe is passed over the teeth four times. The signal created by the laser light reflected by the teeth and picked up by the CCD array is converted into digital data by the computer's signal-processing software. The computer-aided software module, called Euclid, from Matra Datavision, models the 3-d form and the computer then drives the milling machine to cut the denture.

Duret has attracted enough venture capital to put the system into production next year and has formed a company to market it. *–Robert T. Gallagher*

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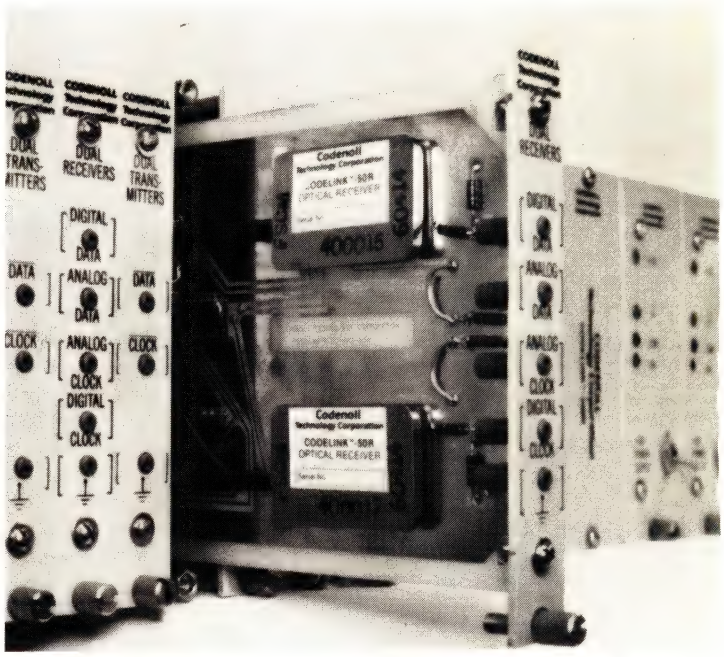

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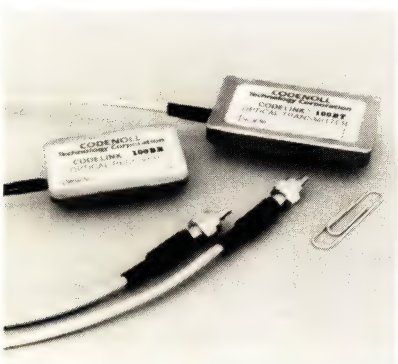

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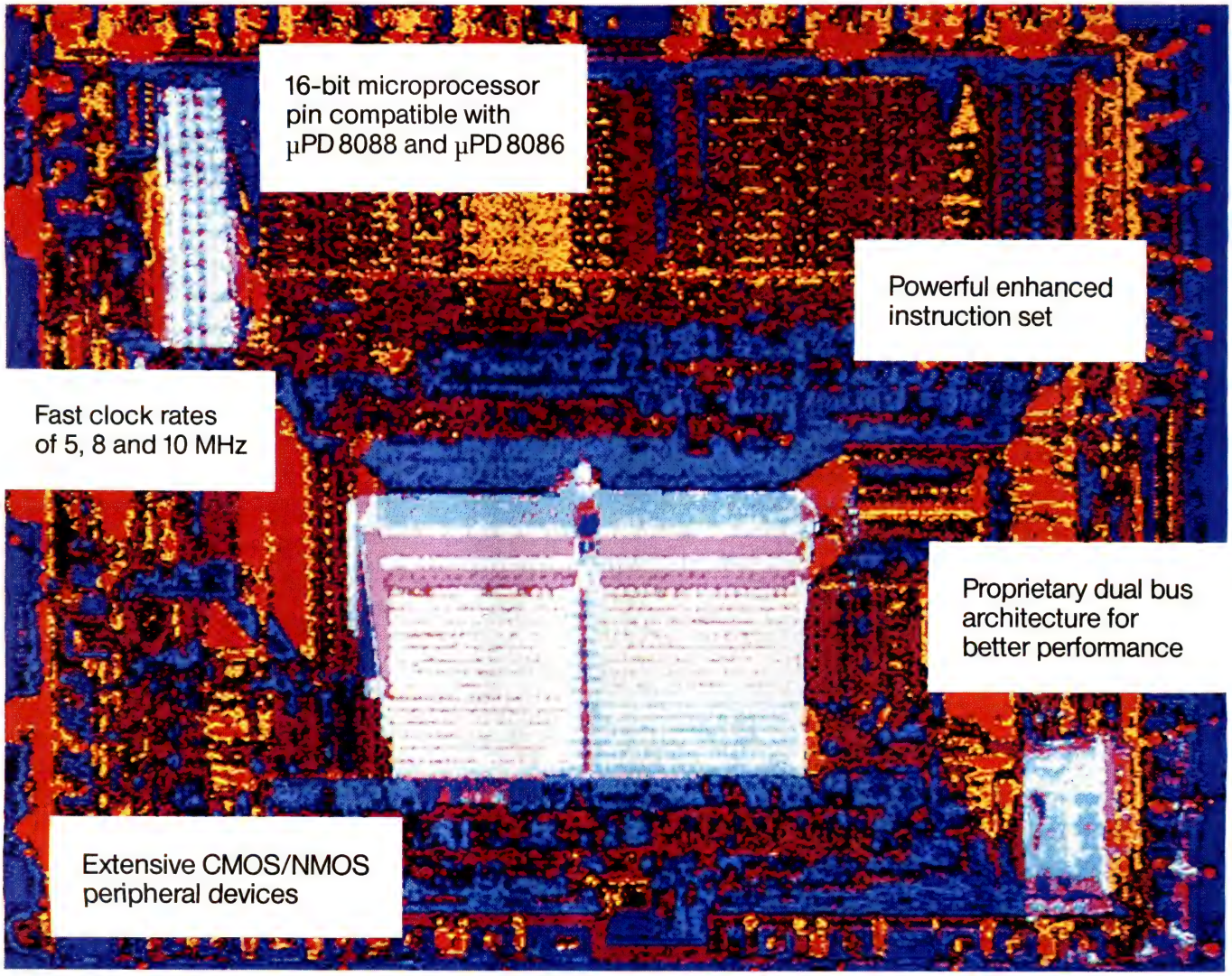

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INSIDE TECHNOLOGY

HOW DOD'S VHSIC IS SPREADING

DESIGNS MULTIPLY AS CHIPS START ROLLING OFF ADVANCED LINES

by Jerry Lyman

After spending $1 billion on the Very High-Speed Integrated Circuits program, the Department of Defense is looking for a big payoff. Now it's beginning to happen. Insertion of VHSIC Phase 1 technology into military electronic systems and projects, which began last year, is really starting to roll.

Phase 1 chips from Honeywell, IBM, RCA, Texas Instruments, TRW, and other companies are now available and have been designed into many DOD systems. And the VHSIC Phase 1 technology has contributed in other major ways. For one, development of the new fine-geometry ICs has spawned a group of high-technology IC fabrication lines with 1.25-μm capability. Establishment of Phase 1 processing lines by GE, Martin Marietta, and Sperry is part of a trend that will soon have a strong influence on the U. S. IC industry—giving some companies a leg up over their competitors with state-of-the art processing lines. Second, the technology is finding its way into commercial products. And third, designers are creating new package types that mix tape automated bonding with multilayer ceramics to house these high-speed, multiple-input/output circuits. Eventually, these packages will migrate down to the commercial world.

Phase 1 of VHSIC was launched in 1981 to develop 1.25-μm-geometry chips to launch two new generations of high-speed military technology to meet the performance specifications of future defense systems. This work was meant to be a stepping stone to Phase 2—military ICs with 0.5-μm geometries [*Electronics Week*, Dec. 17, 1984, p. 57].

In addition to military environmental requirements such as operation from −55°C to +125°C, the DOD specified two key performance requirements—functional throughput rate, the product of density and clock speed (5×10^{11} for Phase 1 and 1×10^{13} for Phase 2) and on-chip clock speed, 25 and 50 MHz, for phases 1 and 2, respectively. (Table 1). VHSIC aims at high-speed signal and image processing, radar, electronic warfare, and other applications where data arrives at a very high rate from various sensors for processing in real time.

VHSIC CONTENDERS

The six prime Phase 1 contractors were Honeywell; IBM; TI; TRW, teamed with Motorola; Westinghouse, teamed with National Semiconductor; and Hughes Aircraft. The first four are the most deeply involved with Phase 1 insertion of their VHSIC-developed chip sets. In addition, Honeywell, IBM, and TRW (again teamed with Motorola) already have been awarded contracts to develop the submicron ICs needed for Phase 2.

Other companies such as General Electric, Martin Marietta Aerospace, Raytheon, RCA, and Sperry are either working on VHSIC insertion contracts or in the process of qualifying for Phase 1 certification.

In Phase 1, Honeywell developed an oxide-isolated high-speed bipolar process with 1.25-μm features and used it to develop three ICs (Table 2). The chips exceed the DOD's functional-throughput-rate requirement of 5×10^{11} gate-Hz/cm^2. The sequencer chip has been verified fully functional at a clock rate over 25 MHz. The arithmetic and parallel-pipeline chips are undergoing high-speed testing, with full performance verification expected in late 1985.

Using its own resources, Honeywell has also developed a 1.25-μm CMOS process to be used in VHSIC insertion. Last month, the DOD approved the use of Honeywell's CMOS-III in the VHSIC insertion program. For the present, Honeywell is the only VHSIC competitor that can furnish both bipolar and CMOS chips for VHSIC.

Honeywell's Systems and Research Center in St. Paul, Minn., designed an electro-optical signal-processor brassboard—a breadboard designed to fit on a vehicle—for Phase 1. The unit uses Honeywell's arithmetic, sequencer, and parallel-pipeline chips to execute highly advanced signal-processing algorithms for a variety of next-generation military systems, such as tactical fighter planes, attack helicopters, shipboard fire control, ground combat vehicles, space station, and space-based surveillance interceptor systems. Honeywell demonstrated a fully functional brassboard in July.

VHSIC TOOL KIT

Honeywell Signal Processing Technologies, an independent merchant arm of Honeywell's Solid State Electronics Division in Colorado Springs, has developed an array of software and hardware tools to help VHSIC contractors insert the signal processor into their systems. These include a Digital Equipment Corp. VAX-based functional simulator, to perform system simulation with Honeywell's VHSIC chip set for both system-design verification and software development; a VAX-based self-contained hardware development system; and an evaluation module (Fig. 1) for prototyping system applications with a minimum investment of time and money.

Honeywell is involved in several other VHSIC insertion programs such as the Mark 50 torpedo sonar processor, which mixes bipolar and CMOS Phase 1 chip technology. Another program is the enhanced modular signal processor, a floating-point system that Honeywell is working on with AT&T Co.

In one in-house project, Honeywell is looking into the application of Phase 2 chip technology to shrink the pin electronics in the test heads of high-speed, high-pin-count automatic very large-scale-integration testers. By shrinking the pin electronics with high-density VHSIC circuitry, Honeywell hopes, it will be relatively easy to fit each pin's driver and receiver circuitry into a test head. This will reduce parasitic inductance and capacitance, minimizing propagation delays.

TABLE 1: VHSIC REQUIREMENTS

Requirement	VHSIC Phase 1 (1.25 μm)	VHSIC Phase 2 (0.50 μm)
Functional throughput rate (gate-Hz/cm^2)	5×10^{11}	1×10^{13}
On-chip clock speed (MHz)	25	100

A TEXAN CHIP SET

Texas Instruments Inc. has developed a set of eight multipurpose programmable VHSIC chips with complete applications support software to configure a broad spectrum of data and signal processors for military systems (Table 3). These 1.25-μm chips include a three-member bipolar family to support a 25-MHz MIL-STD-1750A (a standard instruction set for microprocessors used by the Air Force) data processor with Pascal support environment, a four-chip bipolar family for configuring 25-MHz parallel and pipelined vector or array processors, and an 8-K-by-9-bit 25-MHz n-MOS static random-access memory.

At last month's Government Microcircuit Applications Conference in Orlando, Fla., TI demonstrated a fully functional MIL-STD-1750A data-processor brassboard. A typical data-processing unit (Fig. 2) uses 16 VHSIC standard RAMs for main memory, a device interface unit that can also be used as a coprocessor, and two VHSIC general buffer units. The Dallas company also put the circuitry on a ceramic substrate for a VHSIC module (Fig. 3).

The data-processing and device-interface units each have an on-chip maintenance unit to interface with a system maintenance bus. Built-in test or single-step operation can be done through a four-pin maintenance port or by software command. This feature is in line with VHSIC's aim of building in testability on most Phase 1 chips. TI has built VHSIC Phase 1 brassboards for the Multimode fire-and-forget missile, M1 fire control, launch-and-leave guided bomb, TOW-2 guidance system, and joint-imaging-seeker programs.

Another strong participant in VHSIC insertion is TRW Inc.'s Electronic Systems Group, Redondo Beach, Calif., with a 13-chip family. Eight chips were designed for the original VHSIC proposal, an electronic-warfare brassboard. These chips consisted of a bipolar window-addressable memory, content-addressable memory, matrix switch, register arithmetic-logic unit, address generator, microcontroller, multiplier accumulator, and a four-port CMOS memory.

The five remaining chips—a two-chip set for performing fast Fourier transforms, a convolutional decoder, a convolver, and a configurable gate array—were added later for use in advanced signal processing. Each chip operates at 25 MHz and has on-chip test circuitry for diagnostic purposes. All are available in standard Jedec leaded ceramic chip carriers.

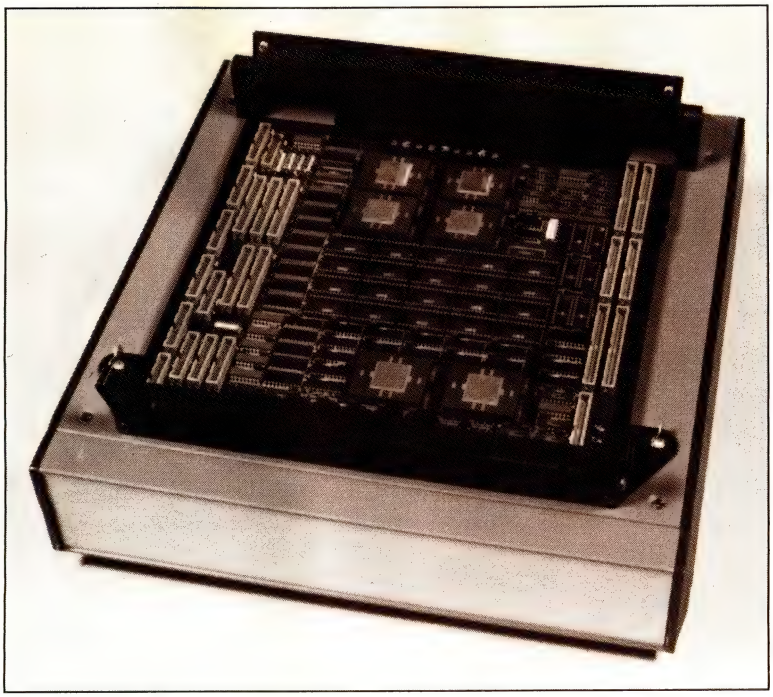
At Gomac, TRW indicated that it currently is involved in at least three Phase 1 projects. In one, it is teaming with General Motors Corp.'s Delco Division to deliver an advanced MIL-STD-1750A processor to the Air Force by 1987. This chip set will be significantly faster (3 million instructions per second, compared with less than 1 mips) than existing processors built to this standard.

TABLE 2: HONEYWELL'S VHSIC CHIP SET

IC	Size (inch/side)	Package pins	Equivalent gates	Device count	Power (W)	Functional throughput rate (gate-Hz/cm^2)
Arithmetic	0.300	180	24,000	121,000	1.8	1.0×10^{12}
Sequencer	0.300	180	27,000	136,000	1.8	1.1×10^{12}
Parallel pipeline	0.310	180	28,000	142,000	2.0	1.1×10^{12}

In a second Air Force program, TRW is applying Phase 1 technology to the existing AN/ALQ electronic-warfare jamming system. The Air Force's aim is to improve both the system's mean time between failures and its logistics—that is, to modularize selected areas of the system for ease of servicing. "This is the first time the Air Force has applied VHSIC technology to improve logistics rather than performance or packaging density," according to Henry M. Dimond, the division's product-line manager.

A third TRW VHSIC insertion program, for the Air Force and Navy, is based on Phase 1 add-on chips. The aim is to enhance the signal-processing circuitry of the two services' extremely high-frequency communication satellites. Delivery is targeted for 1986-87.



1. EVALUATION MODULE. Honeywell's evaluation module is a self-contained electro-optical signal-processor brassboard for prototyping system applications.

Like TRW, IBM Corp.'s Federal Systems Division, Manassas, Va., participates in both Phase 1 and 2. IBM's chips use 1.25-μm n-MOS, have a 15- to 25-MHz clock rate, are TTL-compatible, and have built-in testability. The two original Phase 1 IC types—a signal-processing element and a complex multiplier accumulator—have been available since 1984. This year, IBM is supplying a module, based on the original chips, to execute the FFT.

Not everyone involved in VHSIC insertion is from the original group of six. At least four newcomers are either qualified or about to be qualified as suppliers of ICs based on Phase 1 specifications. These companies are General Electric's Microelectronics Center, Martin Marietta Aerospace, RCA's Solid State Division, and Sperry's Semiconductor Operation.

Of these, RCA Corp. is the most heavily involved, with many VHSIC-related programs based on the company's radiation-hardened ICs, which are designed in CMOS and silicon on sapphire to 1.25-μm geometries. For example, RCA won an $8.2 million contract to develop rad-hard VLSI chips for Strategic Defense Initiative applications. For the Army's Laboratory Command (Labcom) in Fort Monmouth, N.J., RCA has developed two gate arrays (2,700 and 5,000 gates) based on 1.25-μm technology. The aim is to get these units to withstand well over 1 megarad.

For one of the Air Force's many MIL-T-1750A projects, RCA is developing a hardened CMOS-SOS test chip and a 1750A architecture implementation with 1.25-μm, double-level-metal technology. The goal is a rad-hard space-based 1750A processor.

Martin Marietta Aerospace now has a 1.25-μm CMOS capability and is working on inserting a Phase 1 gate array in the Copperhead guided cannon shell. In addition, the Orlando company has a packaging contract from VHSIC for fine-pitch-I/O chip carriers.

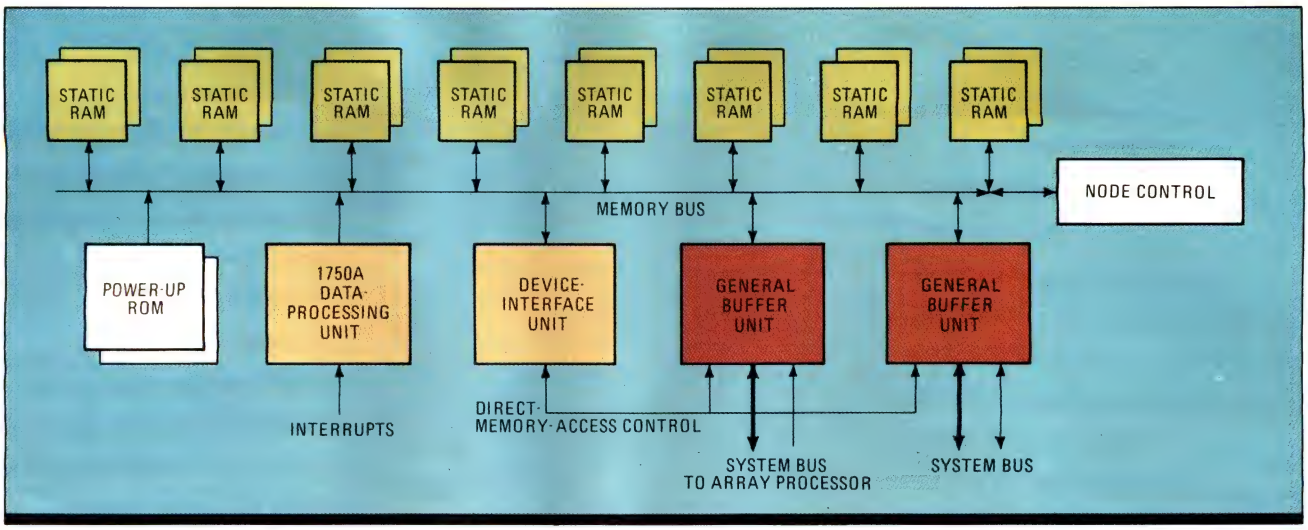
MARKETING THE TECHNOLOGY

GE has established a self-funded 1.25-μm CMOS line at its Microelectronics Center in Research Triangle Park, N.C. The line will produce Phase 1 technology chips for initial use in GE's military projects, but the company plans to sell these chips to other DOD project participants and eventually will market chips with this technology.

Sperry Corp. also has a 1.25-μm capability. It is in the midst of getting approval from the Defense Electronics Supply Cen-

TABLE 3: TEXAS INSTRUMENTS' VHSIC CHIP SET

Type		Component	Implementation	Specification	Package
Schottky transistor logic	Array processor	Vector arithmetic logic unit	dedicated design	17,200-gate/7.9-K ROM; 2.4 W 74 million operations per second, 16-bit arithmetic pipeline	open via chip carrier
		Array controller and sequencer	12,000-gate/64-K ROM gate array	9,800-gate/64-K ROM; 2.0 W general-purpose 16-bit microcontroller	leadless ceramic chip carrier
		Vector-address generator	12,000-gate/64-K ROM gate array	11,000-gate/64-K ROM; 2.2 W two-dimensional address generator	leadless ceramic chip carrier
		Multipath switch	5,000-gate array	3,900-gate; 1.8 W 6 by 6 crossbar switch	leadless ceramic chip carrier
	Data processor	1750A data-processing unit	dedicated design unique ROM programs	15,800-gate/113-K ROM; 2.4 W 4 MIPS MIL-STD-1750A CPU	leadless ceramic chip carrier
		Device interface unit		15,800-gate/113-K ROM; 2.4 W multiprocessor communications controller	leadless ceramic chip carrier
		General buffer unit	14,000-gate array	10,300-gate;1.8 W multimaster 16-bit bus controller	leadless ceramic chip carrier
Memory (n-MOS)		8-K-by-9-bit static RAM	dedicated design	465,000 transistors; 450 mW (60 mW standby) 35 ns access	leadless ceramic chip carrier



2. MILITARY ARCHITECTURE. Texas Instruments Inc. demonstrated a MIL-STD-1750A data-processor brassboard based on its VHSIC chips.

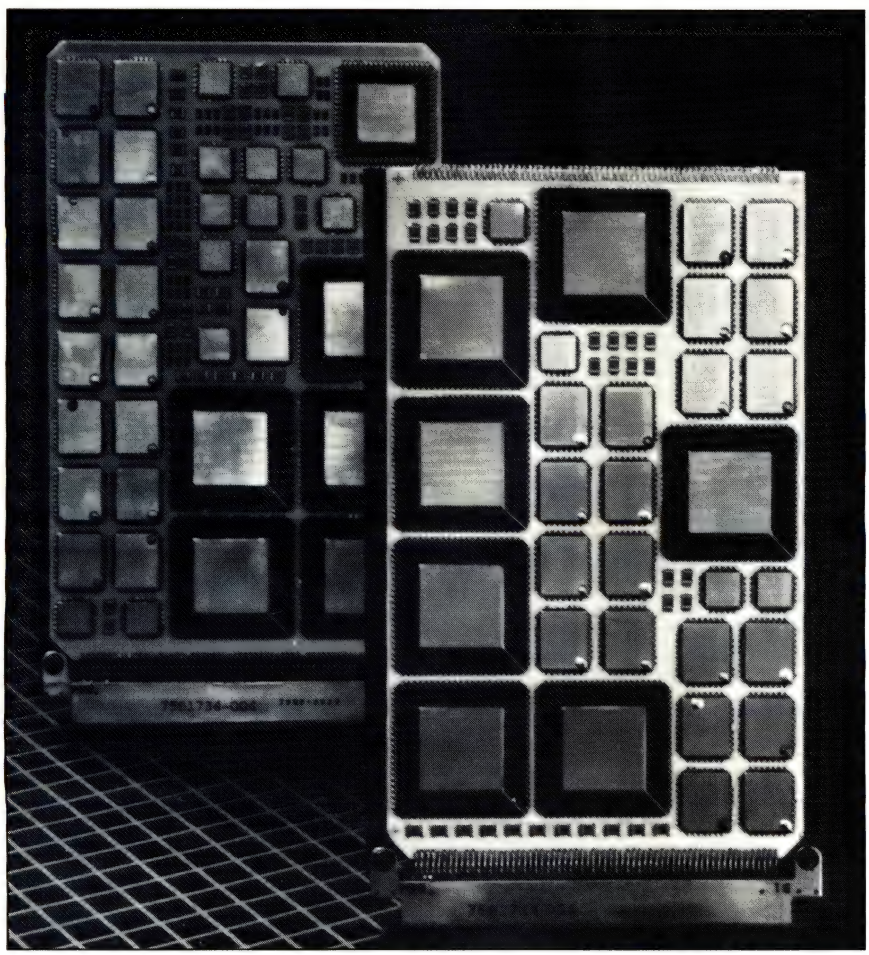
ter to produce chips suitable for Phase 1 insertion for in-house projects at its Semiconductor Operation in St. Paul.

Among the leaders in the new development of processing and fabrication lines suitable for Phase 1 production are Honeywell's Solid State Electronics Division and TI. This is not surprising because both were involved heavily in Phase 1 development and insertion.

Honeywell's facility is the first fabrication line dedicated to producing VHSIC and VLSI chips on 6-in. wafers with 1.25-μm geometries for custom and semicustom products. The highly automated 60,000-ft^2 facility features a Class 10 clean room and 100% automated wafer handling. Ambient temperature is held to within 2° and humidity within 5%.

The line uses the tunnel approach, with the fronts of processing modules placed in the Class 10 facility and the rear of the modules in a Class 100 environment for servicing. All workers must wear special static-resistant space suits to keep down the number of airborne particulates (Fig. 4). By 1987, the division expects to employ 150 people in the fab plant and to generate 850 wafer starts each week.

TI has an operational government electronics front end in Dallas already processing both bipolar and n-MOS Phase 1 ICs. Though rated a Class 10 facility, it actually meets Class 1 specifications. By late 1985, TI expects to add a CMOS capability to this processing line. Few details are available, but the line is known to be fully automated and computer controlled.



3. VHSIC MODULES. TI's 1750A data and array processor modules are being incorporated into several VHSIC insertion programs.

TRW and Martin Marietta have also built 1.25-μm advanced processing lines. Both lines have Class 10 particulate filtering and are structurally isolated from the buildings housing them to minimize vibrations that can critically affect the delicate photolithographic process. Martin Marietta's line is highly automated and uses computerized process control with real-time data collection and analysis for day-to-day support of design and fabrication. Computer-integrated manufacturing techniques result in an ultraclean, paper-free environment.

Though there undoubtedly is a commercial market for Phase 1 chips, it is very unlikely that the DOD will ever let these chips be sold to other than its suppliers [*Electronics*, Nov. 4, 1985, p. 18]. But it is likely that the associated production technology will eventually turn out commercial products using Phase 1 processes and design rules. In fact, this is already happening at Honeywell's Solid State Electronics Division.

In late 1983, Honeywell formed two venture business units in Colorado Springs to generate commercial products derived from Phase 1 technology. The

first products from the Digital Product Center and the Signal Processing Technologies unit have already been introduced.

The Digital Product Center is concentrating on high-density CMOS and high-speed bipolar gate arrays and rad-hard memories and gate arrays. One outstanding product already developed is the HC20000 CMOS gate array. This device, developed for a supercomputer manufacturer, has 20,000 equivalent gates, 400-ps gate delay, and 2.3-W dissipation. The part comes in a 284-pin surface-mountable package, pin grid array, and bare tape-automated-bonding (TAB) chips (Fig. 5).

Honeywell's Signal Processing Technologies operation is aiming at three areas: high-speed data conversion, digital signal processing, and programmable data acquisition. The part targets its products at the military, industrial, and telecommunications areas for such applications as transient analyzers, digital oscilloscopes, medical imaging, and robotics.

VHSIC PACKAGING

VHSIC chips with over 100 I/Os and speeds of 25 MHz or more require special packages. Two package types—chip carriers with leads on 20-mil centers and PGAs with leads on 50-mil centers—have already appeared [*ElectronicsWeek,* Dec. 17, 1984, p. 66]. Both mix multilayer ceramic technology and TAB.

Fine-pitch perimeter packages are one approach to keeping high-I/O chips to reasonable proportions. Under a contract with Labcom, Martin Marietta Aerospace has developed 264-I/O-pin leaded and leadless ceramic chip carriers on 20-mil centers that can satisfy the speed requirements of Phase 1 and 2.

The carrier's basic building block is a ceramic structure produced by Ceramic Systems, San Diego, having five conductor layers—two signal layers, two ground planes, and a power plane. The leaded version has a brazed Kovar lead frame in a gull-wing configuration. The leadless version, designed for vapor-phase soldering to either ceramic substrates or temperature-compensated printed-circuit boards, has solder-plated pads. The carrier's chip cavity is designed for TAB—Martin Marietta believes this will be the bonding method of choice for future VHSIC chips with even higher lead counts.

The package design for a 264-pin version of this unit is complete, as is the TAB design. At present, Martin Marietta is preparing to test the first samples of both the leaded and unleaded carriers.

The other approach to a high-pinout carrier is the 50-mil-centered PGA. There is a distinct size advantage of the 50-mil PGA over a 20-mil peripheral carrier that begins at the 100-I/O-pin level. This becomes an almost 2:1 advantage at the 240-I/O-pin level. Labcom, on the basis of this information, has awarded Honeywell a contract to design a family of 50-mil-centered PGAs to house circuits with 120 to 480 I/O pins.

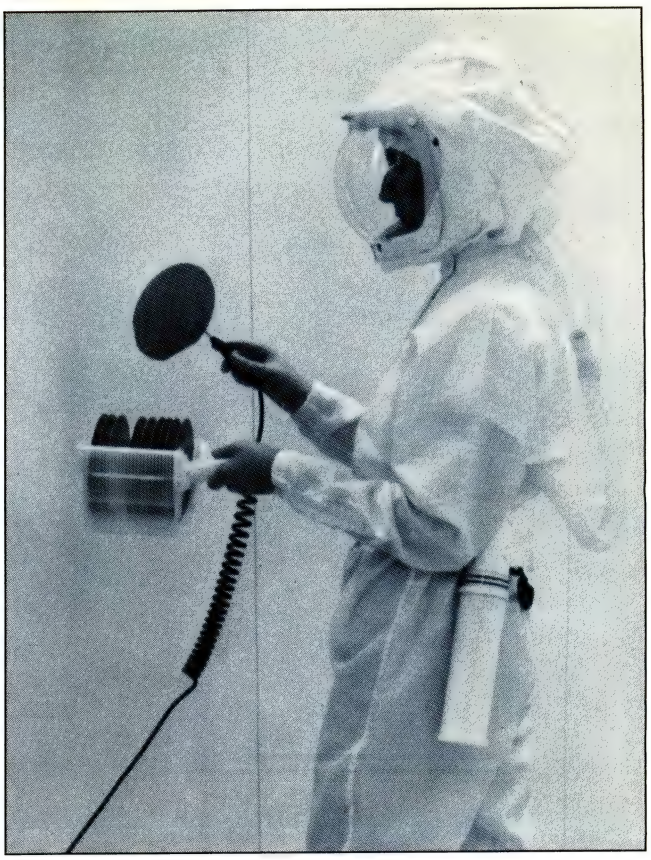
General Ceramics has completed tooling for the 240-pin type. The package is a split array with a channel down its center designed to press against a heat sink or cooling surface. The package is suitable for through-hole mounting or as a pinless pad grid array. Another alternative is to butt-mount the package by shearing the pins to 40-mil lengths.

The multilayer ceramic has seven functional layers using buried strip-line construction with signal-line isolation to minimize crosstalk. Characteristic impedance is 50 Ω.

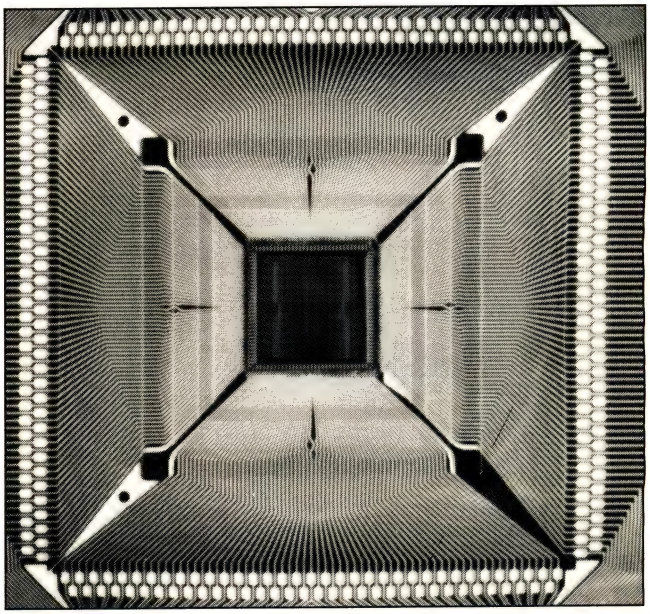
Like Martin Marietta, Honeywell has decided to use TAB for higher-lead-count chips. What is unusual is that, unlike Martin Marietta, Honeywell is solder bumping the TAB chips. This means the chip can attach to the inner leads of the TAB lead frame by some form of reflow soldering rather than wirebonding. Soldering produces a stronger joint than wire bonding. The TAB leadframe's outer leads also solder to the package's cavity.

Honeywell already has demonstrated this pacakge in a 140-lead version using standard 70-mm TAB. Higher lead counts mandate a move to area TAB—a TAB with a grid of internal rather than peripheral pads. Because all pins are under the substrate, it is almost impossible to inspect this package's solder joints by the usual means. To solve this problem, Honeywell designed a special inspection tool built around a rigid bundle of optical fibers terminated in a fisheye lens. With this tool, video images of individual solder joints can be seen.

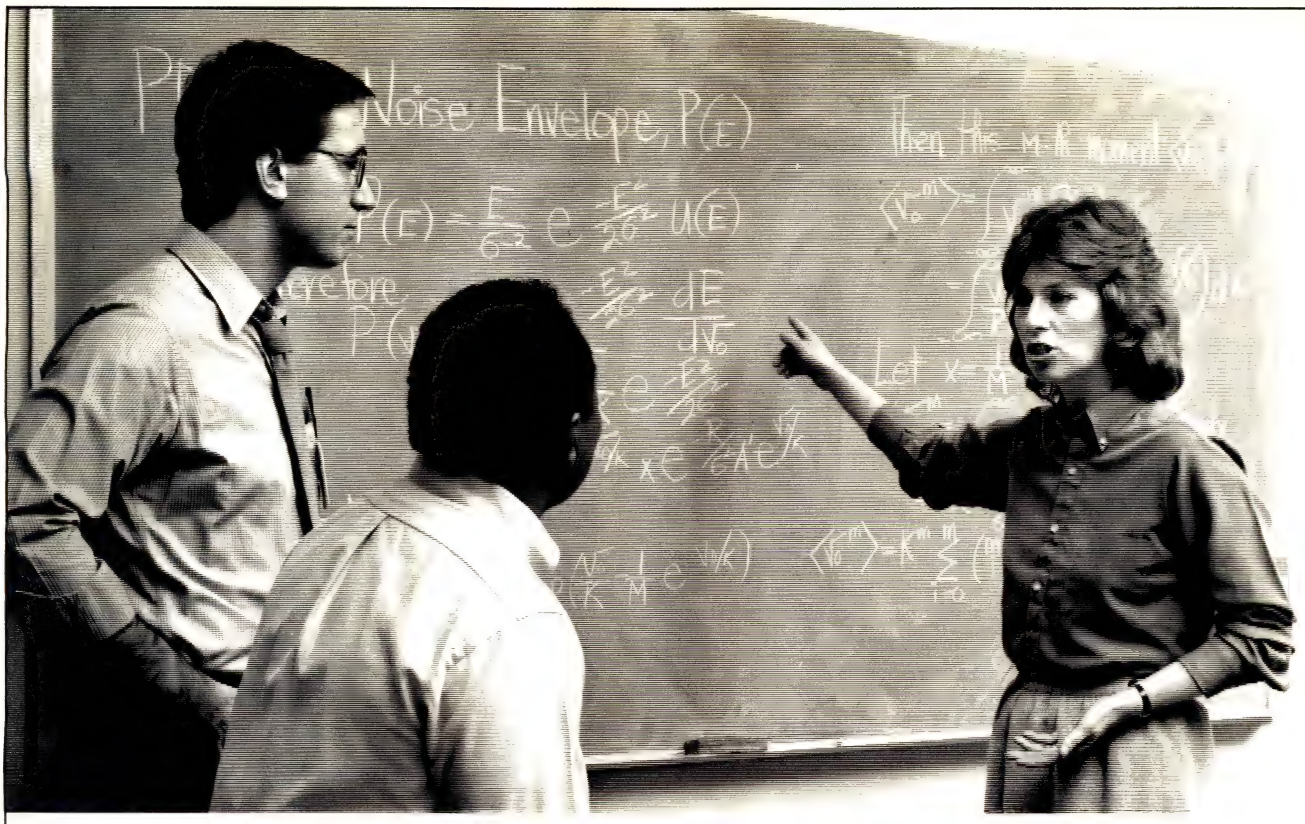
VHSIC's Phase 1 is pushing every facet of IC design, fabrication, and packaging. Phase 2 undoubtedly will extend these interrelated technologies even further. □



4. MRS. CLEAN. A bubble suit keeps purified air circulating around a worker at Honeywell's Class 10 1.25-μm facility in Colorado Springs.



5. SUPER TAB. Advanced chip packages use large TAB frames such as this 284-lead 70-mm pattern for testing, handling, and bonding.



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Henry Ward Beecher, American clergyman

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AN ASSOCIATIVE MEMORY THAT BREAKS THE HARDWARE BARRIER

BUBBLE CHIP REDUCES COMPLEXITY BY COMBINING LOGIC AND MEMORY

Designers have long known that systems that could access stored data according to content would provide a significant jump in speed over systems that access data by location or address. But the complexity of the required memory circuits has thwarted many efforts to implement these associative-search processing systems. Now a Carnegie-Mellon University doctoral student and a member of the school's research faculty have breached this hardware barrier with a fast associative-search processing scheme using very large-scale-integration magnetic bubble technology.

The system, which was designed by Jyh-Ping Hwang and Floyd B. Humphrey, is built around smart magnetic bubble content-addressable memory chips. In combining logic and memory on the same chip, they take advantage of the inherent logic capabilities of magnetic bubble technology to increase speed through the use of massively parallel associative-search processors. They also modified the standard bubble-memory architecture to include search and latch gates to search for and retrieve data. A small-scale prototype of the system has been implemented on semicustom integrated circuits.

The resulting design boosts speed a thousandfold—based on the standard 4-Mb bubble-memory capacity—compared with conventional back-end processing systems using off-chip associative processors attached to the conventional bubble-memory chips. And the system will get faster, the Carnegie-Mellon team predicts, with expected increases in bubble-device density and in the number of search processors used on a single content-addressable bubble-memory chip. Compared with conventional von Neumann-type systems, they note, a content-addressable bubble-memory system improves speed by five orders of magnitude in associative searching of a 10-megabyte data base—and this speed will increase further as the size of the data base increases.

Replacing the address-by-location memory architecture with an address-by-content scheme simplifies programming considerably, and improves the speed for many memory-intensive applications. Storage interpolating, catalog-lookup programs, and information-retrieval and pattern-recognition software are

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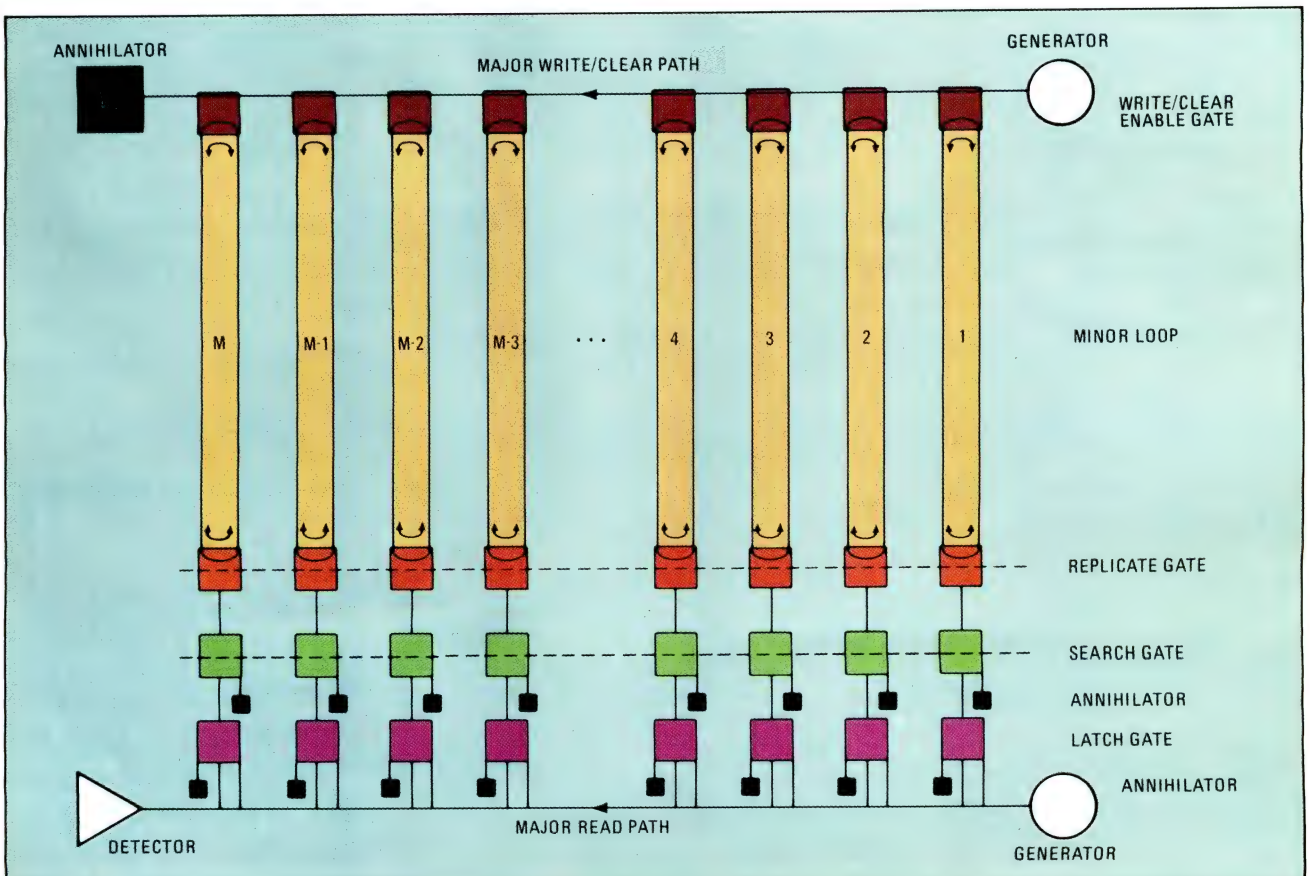
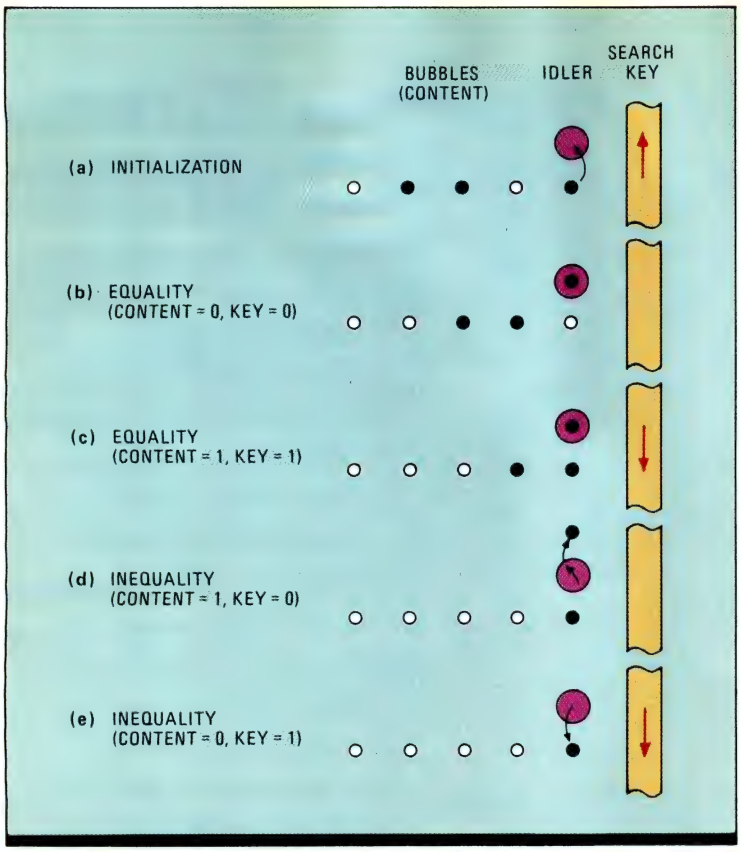


1. LOOP THE LOOP. The associative-search processing system's content-addressable bubble-memory chips feature conventional major- and minor-loop organization for bubbles, to which search, latch, and write- and clear-enable gates have been added.



2. BUBBLES. Search gates perform the associative-search function of the bubble memory.

some of the applications that can benefit from content addressability.

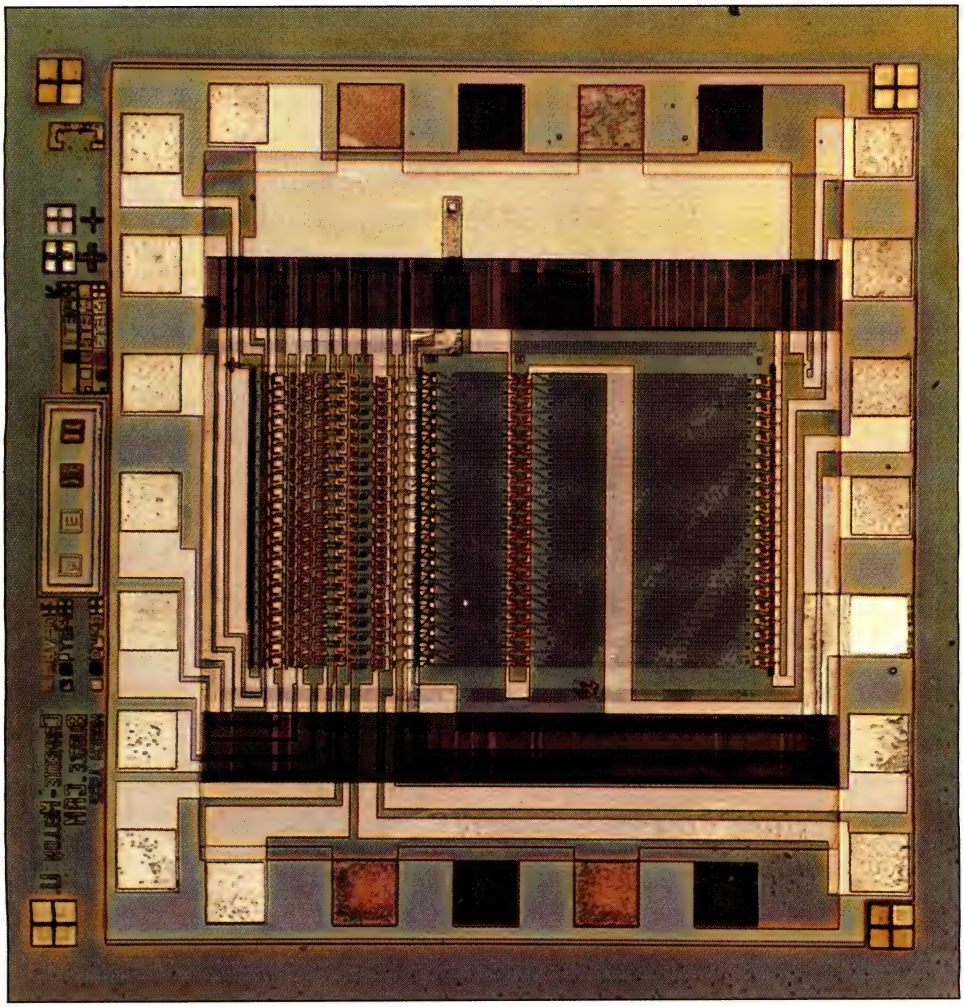
The intrinsic logic capabilities of magnetic bubble technology make it the ideal storage medium for implementing a fast parallel associative-search processing system. The bubbles can be configured into shift registers and are the natural elements for pipelined operations. Each chip contains up to 4,000 shift registers, with each shift register equipped with an associative-search processor. Within the memory, the bubble bits move simultaneously, providing the basis for parallel processing.

Each content-addressable-memory chip implements the basic functions of an associative-search processing system—search, read, write, and clear. The simplest search functions are exact match (equality) and its complement (inequality). Numerical-comparison search functions add additional versatility.

During a search, information is retrieved simultaneously from every memory word and compared, in parallel, with the desired information, which is called the search key. After a search, all stored memory words whose contents match the search key are marked. Priority of access to the matching word locations is assigned to handle the multiple-match situation: matched data can then be read in succession. The write and clear functions allow stored information to be modified.

The architecture maintains the standard bubble-memory parallelism, pipelining, and synchronization features, as well as the *minor-loop* and major-read-path organization (Fig. 1). Data stored in the content-addressable bubble memory is arranged in tabular form. A data record is stored in a single minor loop. Different records are stored in different minor loops, with the start of each record at the same position in each minor loop. All records in the minor loops advance synchronously, maintaining alignment between the different records. Records propagate in word-parallel bit-serial fashion.

A major modification to standard bubble-memory architectures is the addition of search gates and latch gates, which have been inserted between each minor loop and major read path to search for and retrieve the data. Write-enable and clear-enable gates also have been inserted between each minor loop and major write and clear path to perform the write and clear functions. Because bubble storage architectures can contain as



3. PROTOTYPE. Carnegie-Mellon's semicustom bubble-memory associative-search chip incorporates a bubble fence to keep unwanted bubbles away from the main storage.

many as 4,000 minor loops, it is an advantage to have all minor loops and search gates operate in parallel.

The search gates compare the data streams with the search key. To search for a content in the records, the first bit of each record is duplicated and fed to the search gates simultaneously for comparison. The second bit is then processed and so on until the entire search key is scanned.

Upon completion, the records with matched contents are marked in the search gates. The latch gates open or seal the interrogation passages that deliver the data from each minor loop to the detector through the major read path. To read the matched records after the search, the latch gates of the matched records are opened sequentially for orderly data retrieval. The write- or clear-enable gates allow the propagation path to be cleared as the new record is generated.

FREE ASSOCIATION

Each search gate consists of an input bubble stream, a control current, and an idler. The search function is activated by associating the bubble streams from the stored records in the minor loops with the control currents representing key words to be searched. The presence, or activation, of a bubble (the control current) represents a logical 1; the absence, or deactivation, represents a logical 0. The searched results—which are indicated as match or mismatch—are registered in the idlers of the search gates.

To start a search, an initialization current must first be applied to load the idler with a bubble (Fig. 2a). The bubble will remain in the idler as long as the content of the bubble stream is equal to the search key—such as when the stream has a 0 and the search key a 0 (Fig. 2b). When the bubble stream has a 1 and the search key a 1, the idler bubble again remains in place (Fig. 2c). Once inequality occurs—when the stream has a 1 and the search key has a 0—the idler bubble will be cleared (Fig. 2d). The bubble is transferred out of the idler when the bubble has a 0 and the search key has a 1 (Fig. 2e).

Once the idler bubble is lost in the first mismatch, that record is not matched. Though the bubble stream continues, the gate no longer functions because the idler bubble is gone. The important feature of this gate is that the conductor couples all minor loops so that the search is made simultaneously on as many records as minor loops.

Latch gates and various annihilators—which get rid of bubbles by turning them to 0—are inserted between each search gate at the end of a minor loop and major read path. With the data stream interrupted, the search gate's control conductor is pulsed to transfer all idler bubbles remaining after the search to the major read path, where they are delivered to the detector in serial. The bubble controller receives information concerning the location of the matched record and determines the priority of access to the matched record location. The latch gate controls the opening and closing of the interrogation passage, which delivers bubbles from the minor loop to the detector through the major read path. After retrieving all the matched records, the idler bubbles are cleared and discharged.

An associative-search processor has been implemented on a semicustom VLSI circuit (Fig. 3). Many of these processors would be combined to make up a full system. In the chip's center, minor loops are repeated into a storage array. To the right of the storage array, each minor loop is equipped with a search gate and the major read path. Write- and clear-enable gates, to the array's left, are inserted between each of the minor loops and the major write path. A bubble fence—an array to keep unwanted bubbles away from the main storage area—is set around the storage array to keep the unwanted bubbles away from the central area.

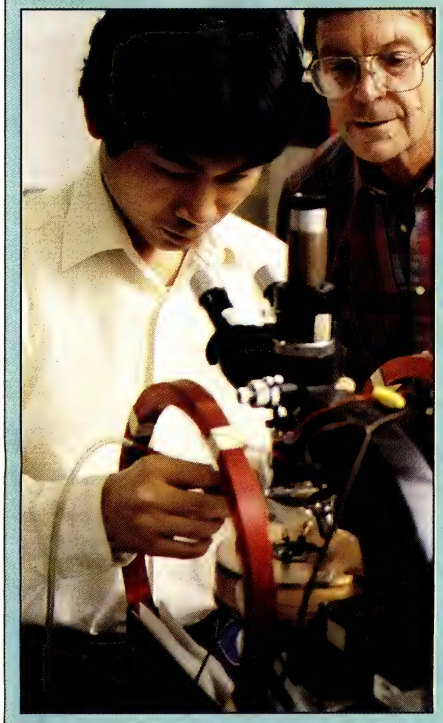
The dark areas adjacent to the top and bottom sides of the storage array comprise the potential equalizer, which forces input currents from bonding pads to flow uniformly across the width of the conductor sheet. The bubble associative-search processor, including the search and latch gates, occupies a reasonably small area, considering its versatile and complex functions.

The current design, say Hwang and Humphrey, is "insignificantly small compared to typical minor-loop lengths (several thousand bits per minor loop) presently available." Because the chip occupies only a 56-bit area, "the employment of a large number of search processors on a single bubble chip is possible, thus exploiting parallel processing to a much greater degree than off-chip processing schemes."

Unique to content-addressable bubble memory is the fact that the address is clearly defined by the rotational position of the minor loops, a feature that facilitates data retrieval after search. It also provides bookkeeping capability so that it is possible to locate empty positions to store new data or occupied positions to be cleared of old data. Moreover, it allows the content-addressable bubble memory to operate as conventional memory, thus generalizing the use of the design. □

THESIS LEADS TO ASSOCIATIVE-SEARCH SYSTEM

The work on the associative-search processing system at Carnegie-Mellon University began as part of Jyh-Ping Hwang's thesis project. The effort was guided by Carnegie-Mellon magnetics expert Floyd B. Humphrey. Hwang designed and fabricated the semicustom integrated circuits used to demonstrate the project's feasibility. Last May, he received his doctorate in electrical and computer engineering from the school.



SMART. Hwang and Humphrey designed an associative bubble memory.

The 31-year-old Hwang came to the U. S. from Taiwan in 1979 after earning a bachelor's degree from Nation Chatung University. Currently, he is an electrical engineer at General Electric Co.'s Cooperative Research and Development Center in Schenectady, N. Y., where he is researching advanced CMOS circuit and systems design projects as part of the company's very large-scale integration and computer-aided-design operations group.

Humphrey was a professor of electrical engineering at the California Institute of Technology for 20 years, where he earned his doctorate. The associative-search processing system grew out of his Caltech research into the fundamentals of bubble motion. He continued this work along device-oriented lines after joining Carnegie-Mellon in 1980. Initially a professor of electrical and computer science, he switched to the school's research faculty last July.

Humphrey notes that interest in bubble memories is on the wane, but foresees a future for the technology as a part of the emerging Bloch-line memory, a superdense storage technology built in part on Humphrey's work.

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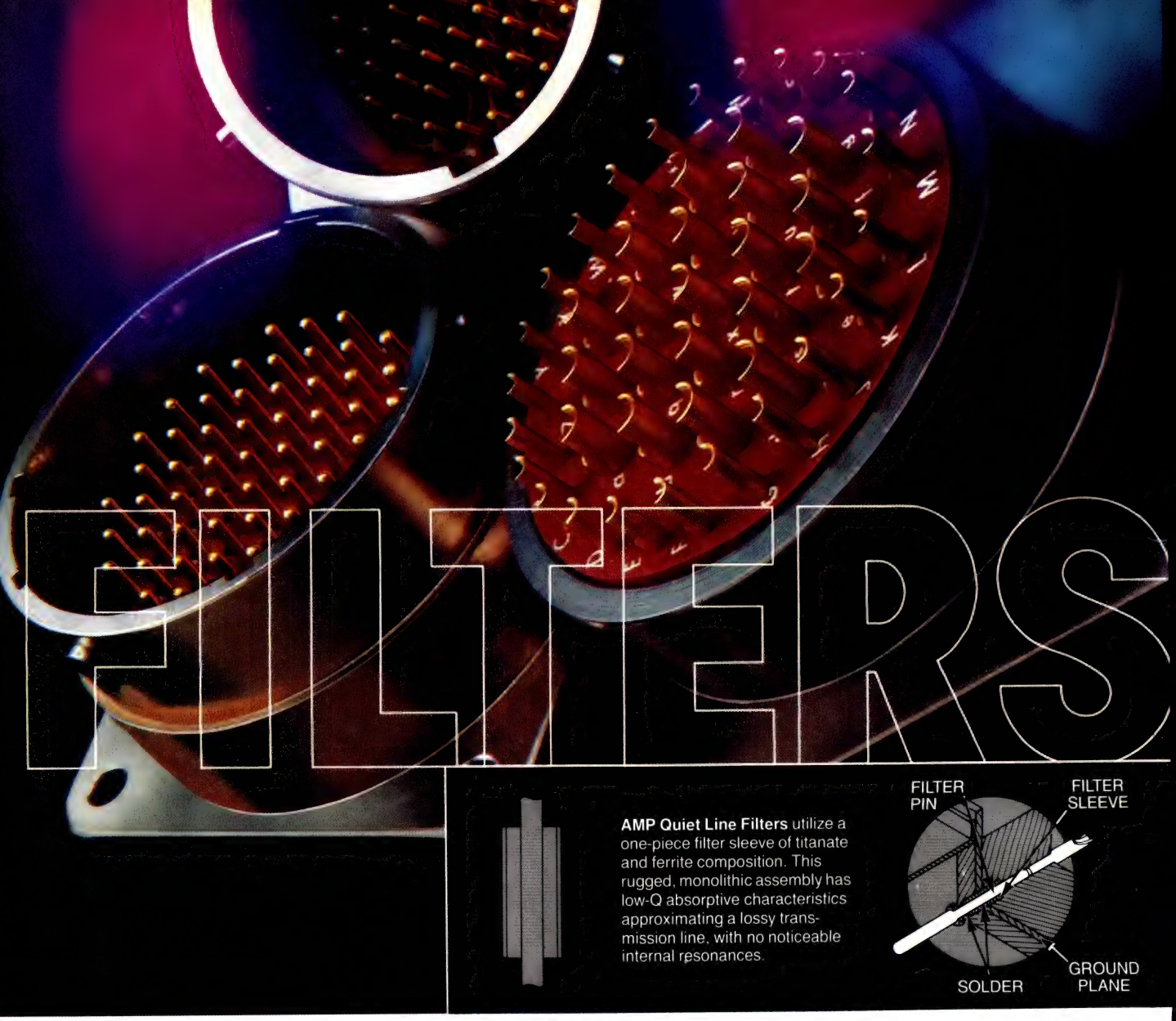

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Circle 44 on reader service card

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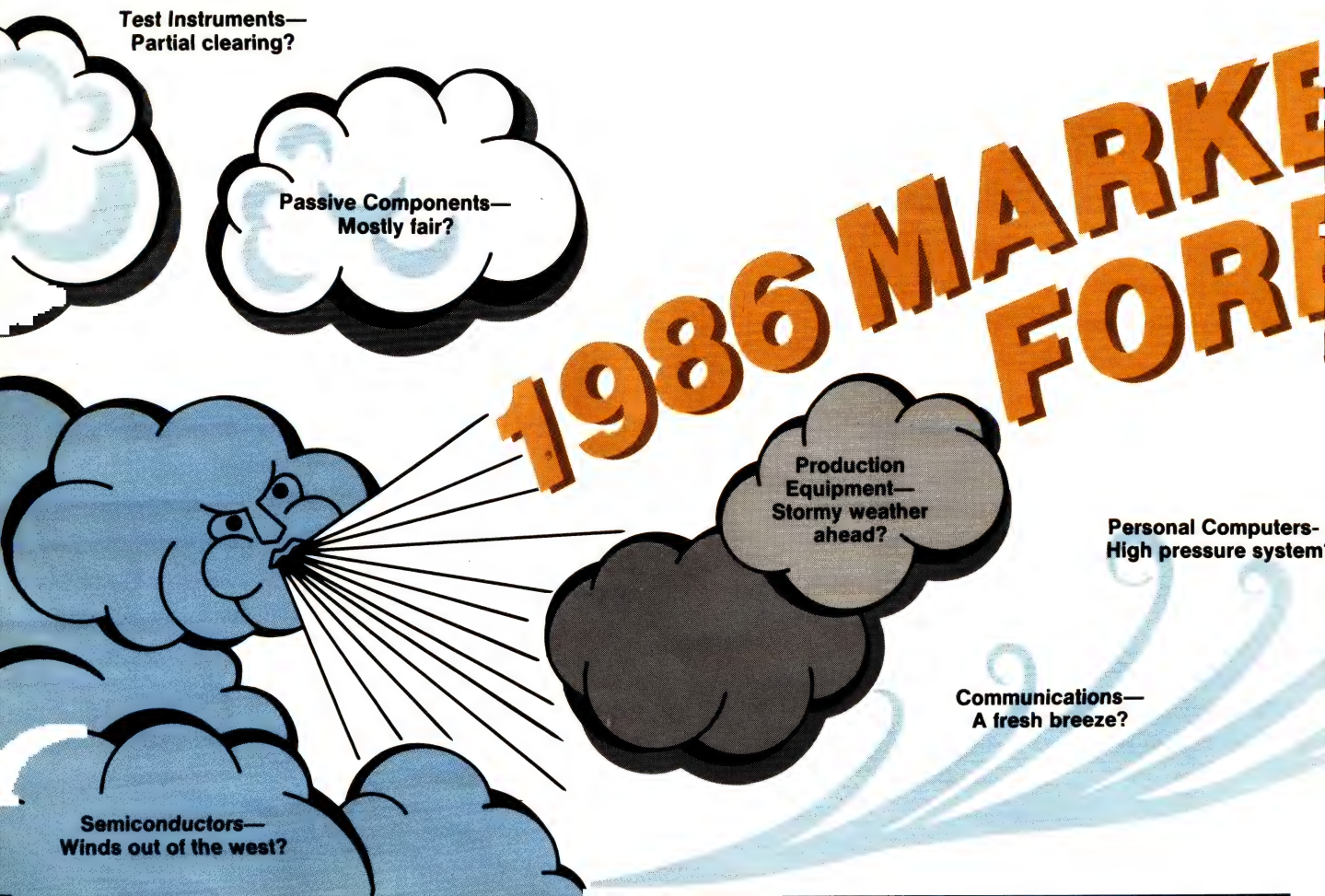
THREE BLOCKBUSTER ISSUES THAT FORECAST THE FUTURE OF DOMESTIC AND INTERNATIONAL MARKETS.



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PROBING THE NEWS

MCC: THE RESEARCH CO-OP'S SURPRISING FAST START

PROJECTS ARE AHEAD OF SCHEDULE AS MEMBERS INCREASE SUPPORT

by J. Robert Lineback

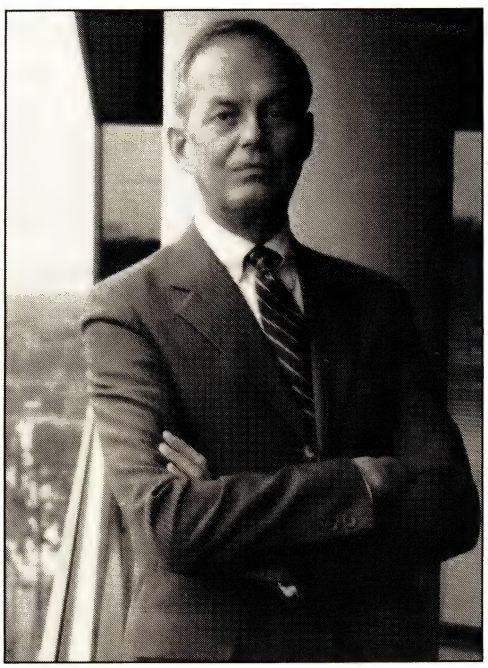
AUSTIN, TEXAS

Skeptics have maintained that a research cooperative won't work in America. But Microelectronics & Computer Technology Corp. is doing so well after just one year of operation that it is surprising even its own supporters. The consortium has jumped well ahead of its original schedule for delivery of technologies to sponsoring companies as it attempts to shape the future of the U. S. electronics industry.

The sense these days around MCC's Austin headquarters is that U. S. business competitors have already proved they can pull together in a research and development consortium to tackle new technologies. "Cooperation works!" exclaims William C. Norris, chairman and chief operating officer of Control Data Corp., Minneapolis. Norris was the one who first proposed the formation of MCC in early 1982 as a response to Japan's highly organized competition [*Electronics*, March 10, 1982, p. 97].

MCC is now enjoying growing vocal and financial support from practically all its 21 shareholding companies as it leaps into the critical technology-transfer era. The only question marks are the status of two members—Mostek Corp., which risks losing eligibility now that it is owned by a foreign company (Thomson-CSF of France), and BMC Industries Inc., which is divesting its electronics businesses and wants to sell its MCC share.

In recent weeks, MCC has formally delivered to sponsoring companies several examples of its early handiwork. Transfers in December covered a range of experimental technologies, from software for direct manipulation of computer graphics to a silicon-compiler package running on an engineering work station. The silicon compiler, written in 80,000 lines of C-language code, is expected to be MCC's first prototype, to be used as the basis of future commercial products. (A formal transfer is one that is documented and will be supported for a certain period by MCC; technology that is turned over without this support is an informal transfer.)



ANOTHER TERM. MCC president Bobby Inman has renewed his contract for another year.

The latest wave of technology transfers caps a year of changes for MCC. Originally, it had planned to deliver during 1985 only technical reports from its seven R&D programs to program sponsors, says chairman and president B. R. (Bobby) Inman. But program-review sessions conducted early in the year created such heavy interest in applying the R&D that MCC has elected to periodically deliver to sponsors some of its laboratory development tools, findings, and experimental software.

"I'm skittish about what I say here because all of these [transfers] have been proprietary releases," says Inman. "But we have learned how to do things that have a potential application now.... We had not planned any deliverables other than the technical reports during the year. But we have made some transfers and that's the best news of all."

MCC's shareholders are becoming much more comfortable with the consortium concept, says Inman, who has renewed his original three-year contract for at least another year. "The companies were at the outset suspicious of one another," he recalls. One measure of how companies have relaxed is the change in the requirement of a unanimous vote on bylaw amendments, a protection mechanism placed in MCC's charter. That requirement was reduced in September to a three-fourths vote.

Shareholding membership has grown from 12 to 21 since 1982. MCC also has 13 nonvoting associate companies, which do not receive proprietary technology but are briefed on the programs' general progress. The cost of full membership has increased to $1 million from the original entry fee of $150,000. And MCC will also tack on a surcharge of 25% of the previous costs of an R&D program whenever a member enters a project.

In Austin, MCC employs 390 people and plans to add another 60 to its expanding technology programs in 1986, says Inman. It expects to consolidate its work force, except for the semiconductor packaging lab, inside a new headquarters, scheduled to be completed by the start of next summer.

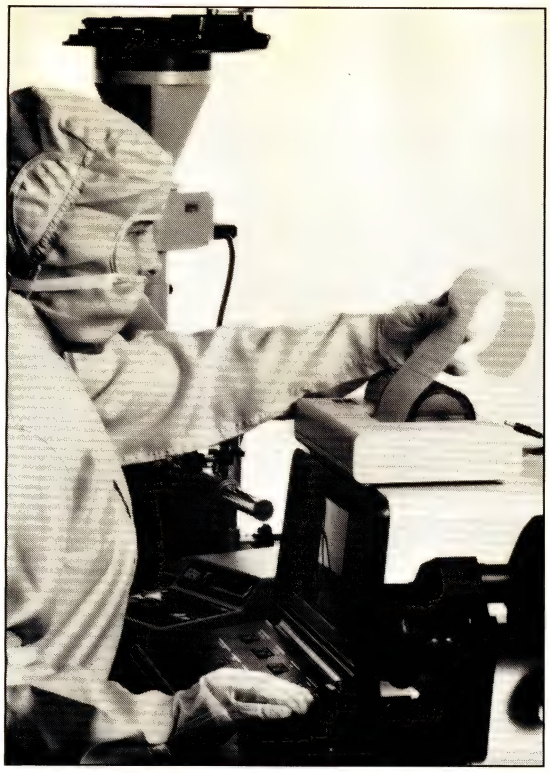
BROAD RANGE. Its programs are in chip packaging and interconnection, computer-aided design for very large-scale integrated circuits, software, and advanced computer architecture (chart, p. 50). The advanced computer program is split into four programs—human interface, data base, parallel processing, and artificial intelligence.

Each has been picking up sponsors. Packaging has increased from 6 to 11; VLSI CAD, from 10 to 12; software, from 6 to 10; and advanced computer architecture, from 6 to 8. Palle F. Smidt, senior vice president for programs and plans, estimates that sponsoring program members have increased their

spending by about 40% over the targeted amounts. Although additional R&D programs have been tabled for at least a year, MCC continues to be interested in new projects. Two strong candidates are high-speed local-area networks and semiconductor processing.

Nearly all the seven individual R&D programs have transferred some technology in their first year of research. An informal delivery of the earliest technology came from the AI project last spring in the form of an experimental expert-system shell known as Proteus. Written in Lisp, it aims at giving sponsors experience with MCC's techniques for truth maintenance and building knowledge bases.

In packaging and interconnection, a two-day laboratory session earlier this year updated sponsors and provided hands-on experience with equipment while reviewing the program's bonding equipment. The packaging program has since made several informal transfers involving thin-film technologies.



PACKAGING. Researchers in MCC's semiconductor packaging and interconnection program work in a 60,000-ft² lab.

The first formal delivery of major packaging objectives, involving tape-automated bonding and thin-film technologies, is due in the first half of 1986. Many of MCC's first patent applications, to be filed in the coming months, will cover these technologies, says John T. Pinkston, the consortium's vice president and chief scientist. The overall program objective is to reduce interconnection levels. The project is attempting to increase the amount of silicon area on a board from 5% to 10% today to 25% to 50%. The program also recently expanded to cover high-temperature packaging as well as single-chip packaging.

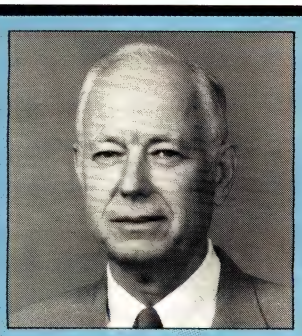
But the first significant formal transfers of MCC technology have come from the VLSI-CAD program. In November, its sponsors received a complex Lisp-based software development platform for what next year will be an interactive work station. The platform consists of 30,000 lines of code and breaks new ground in the form of advanced constructs. This month, MCC plans to ship the prototype module editor, which performs silicon compilation on an Apollo work station.

DO IT NOW. The silicon-compiling module editor was written in C during the early stage of the program's research, and since it was working, program leaders elected to make it available to sponsors. Half the package's 80,000 lines of code are support mechanisms, such as help statements for users. The package will be converted to Lisp for inclusion in the work-station package, which is slated for formal delivery in the second half of 1986. Still, several sponsors have expressed interest in receiving the C-based module editor for possible use in commercial products.

The C-based package will allow sponsors to get an early jump in constructing chip-design libraries for the Lisp-based interactive work station, says John R. Hanne, MCC vice president and VLSI-CAD program director. Both the C-based silicon compiler/editor and the future Lisp-based interactive work station have encoded into them extensions of the industry's emerging Electronic Design Interchange Format.

Design of the interactive VLSI-CAD package will be frozen in June, and by fall the program plans to formally transfer as much as 1 million lines of Lisp code. The VLSI-CAD project is officially chartered to create an interactive work-station package that can do

MCC MENU INCLUDES FULL RANGE OF . . .

LEADER	 WOODROW BLEDSOE	 EUGENE LOWENTHAL	 RAYMOND ALLARD	 STEPHEN F. LUNDSTROM
PROGRAM	ARTIFICIAL INTELLIGENCE	DATA BASE	HUMAN INTERFACE	PARALLEL PROCESSING
SPONSORS	BELLCORE, CONTROL DATA, DEC, KODAK, HARRIS, HONEYWELL, NCR, SPERRY			

SOURCE: *ELECTRONICS*

200,000-transistor ICs in as little as one month. And Hanne's staff actually has its eye on designs of 1 million to 10 million transistors.

Even though the software program got off to a late start in September 1984, MCC officials say it is almost fully staffed and research has begun. Some technical reports have been delivered to the growing group of sponsors.

Early this year the program's objectives were revamped, says Pinkston, making its long-term goal the automation of the "upstream" portion of software design, as opposed to downstream coding of programs. Upstream development, which includes definition of requirements, algorithm selection, and decomposition of programs into smaller blocks, consumes about 50% to 60% of today's software design, estimates Pinkston.

MCC's software people have even developed a two-edged acronym—Leonardo—for their work: it honors the Florentine artist and engineer Leonardo da Vinci and also stands for Low-cost Exploration Offered by Network Approach to Requirements and Design Optimization. The Leonardo package's job is to create a work station for large software systems developed by a team of professional programmers, says Pinkston.

HIGHER RISK. Though there have been informal transfers, formal deliveries of software technology are not expected for several years. "It is an area of higher payoff, but, like many of our program objectives, is also one of higher risk," he adds.

Perhaps the highest risk for MCC is its 10-year project aimed at creating advanced computer technologies, most of which are intended to be applicable to systems of the 1990s. "We've avoided trying to get any quick points by delivering technologies to our sponsors. Our brass ring is way out there in the future," says Eugene I. Lowenthal, vice president and director of the data-base program. He does not expect to transfer any hardware or software prototypes for two or three years. In 1986, the program will concentrate on concepts born during what Lowenthal describes as "free-flowing brainstorm sessions of the past year."

In the other computer programs, formal technology transfers are not expected for several years—though there will be technical reports as well as several informal deliveries in human-interface software and AI. Project leaders and sponsors, however, are trying out the transfer mechanism in the long-term computer thrust.

MCC's highest risk is project for computers in the 1990s

For example, the human-interface project this month delivered examples of experimental software for syntax analysis of knowledge-base interfaces as well as for graphics manipulation. For the most part, 1986 will involve experimentation and testing of user-interface concepts, says Raymond W. Allard, vice president and program director of human factor technology.

In 1987, prototype systems will be integrated to tackle two general areas: operation of a computer through multimode input/output, such as keyed commands, voice, and image recognition; and a flexible language for expert systems, leading to knowledge bases that are rich in semantics. The program is also pioneering computer-assisted programs in which the system will answer questions from users and provide unsolicited coaching at the appropriate times.

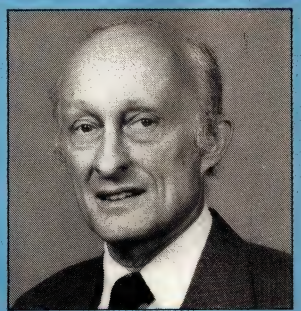
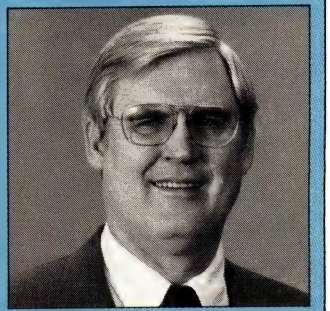
MAKING SENSE. MCC's AI program is aiming at eventually creating a massive common-sense data base consisting of 10^{11} bits. "Of the seven [programs], ours is the most 'researchy' and long-term. Even the very nature of the game—intelligence—is not well understood and is in the research stage," notes Woodrow W. Bledsoe, vice president and program director. "I would rather lay low and have a chance to work hard at this."

Adding to the upbeat feeling at MCC is the fact that members are signing up for additional MCC programs after seeing the talent assembled. Motorola Inc., which was in the CAD project, this year joined the software program as well. Honeywell Inc. was in the computer program only and later joined the CAD project. Advanced Micro Devices Inc., which was in CAD, added the packaging program to its sponsorship. "One of the things we considered when we were looking at joining packaging was how well we are doing in the CAD program," notes Philip Downing, AMD's corporate vice president of technology and a member of the consortium's technical advisory board.

MCC's newest member, Bell Communications Research (known as Bellcore), sees MCC as an extension of its long-range research for the Bell operating companies, says Henry Pollak, assistant vice president of mathematics, communications, and computer sciences research. "I'm very happy with it," he adds.

Allied-Signal Corp., which is in the packaging program, is reviewing some of the other MCC programs, says Phillip W. Arneson, president of the company's Amphenol Products Co. subsidiary in Lisle, Ill., and a member of the MCC board. "The question—can something like this work?—is still an important one," says Arneson. "Only in the future, when we look back, can we say it did. But I would like to look back and say, 'It is still working.'" □

. . . COMPUTER, SEMICONDUCTOR, SOFTWARE PROJECTS

LEADER	 BARRY WHALEN	 LASZLO A. BELADY	 JOHN HANNE
PROGRAM	SEMICONDUCTOR PACKAGING AND INTERCONNECTION	SOFTWARE TECHNOLOGY	VLSI COMPUTER-AIDED DESIGN
SPONSORS	ADVANCED MICRO DEVICES, ALLIED-SIGNAL, BMC INDUSTRIES*, BOEING, CONTROL DATA, DEC, EASTMAN KODAK, HARRIS, MOSTEK*, SPERRY, 3M	BELLCORE, CONTROL DATA, DEC, HARRIS, LOCKHEED, MOTOROLA, NCR, SPERRY, RCA, ROCKWELL	AMD, CONTROL DATA, GOULD, HARRIS, HONEYWELL, MARTIN MARIETTA, MOSTEK*, MOTOROLA, NATIONAL SEMICONDUCTOR, NCR, RCA, SPERRY

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JAPAN'S NEW PUSH: SELF-SUFFICIENCY IN SILICON

MITI GROUP AIMS AT TAKING OVER THE LOCAL POLYSILICON MARKET

by Michael Berger

TOKYO

The Japanese are hatching another surprise for foreigners dominating one of their local electronics markets. They have set a new technological challenge for themselves: achieving self-sufficiency in the production of polysilicon—the "crude oil" of the semiconductor industry. The challenge is also a direct threat to the supremacy of foreign suppliers, who account for 50% to 60% of Japan's $100 million poly market.

The Japanese also aim to nip in the bud an imminent invasion by foreign producers that hope to increase sharply their current 5% share of the Japanese silicon-wafer market, which was worth $600 million in 1984 and about $480 million this year. Unlike past Japanese technology drives, which often resulted in foreigners losing their Japanese market share, the silicon challenge will be a difficult one for the Japanese to accomplish, industry executives and analysts alike believe.

A two-year study by a special group organized in the Ministry of International Trade and Industry strongly recommended recently that Japanese companies form a joint technological-development organization to reduce their dependency on foreign silicon supplies and increase their ability to compete in foreign markets.

The proposal came as a shock to foreign suppliers. "We were surprised. We had no idea that the MITI study group even existed," says Werner Freiesleben, president of Wacker Chemicals GmbH, Munich, which claims a 50% share of the Japanese poly market. "But when we realized what was happening, we restructured our entire approach to the Japanese market. We now plan to produce polysilicon here by 1990, perhaps earlier."

If Wacker was surprised, Monsanto Japan Ltd. was shocked. The U. S. maker already had committed $100 million to the construction of a wafer-production plant at Utsunomiya, north of Tokyo, in a major effort to build its share of the Japanese wafer market from less than 2% into double digits. "This report is not going to affect our investment," says Charles W. Cook Jr., vice president of Monsanto Japan's Electronic Materials Division. "We must succeed in Japan to be a factor in the world market. It'll be more difficult now, but this game is being played for keeps."

MORE PLAYERS. What most worries Cook and other executives, including some Japanese, is that MITI's call for silicon self-sufficiency will produce more players than the market can accommodate. Even nonelectronics companies are getting involved.

Despite the severe semiconductor market slump and a reduction in silicon inventories, the MITI study forecasts that by 1988, semiconductor demand worldwide will be close to $12 billion—about triple the 1982 figure. Demand for silicon, meanwhile, is expected to increase annually between 25% and 30%.

JAPAN IMPORTS HALF ITS POLYCRYSTALLINE SILICON (in tons)

Year	Domestic production	Domestic sales	Exports	Imports (%)
1980	470	30	3	280 (37)
1981	576	29	7	400 (41)
1982	590	24	17	550 (48)
1983	649	37	7	800 (55)
1984	913	54	16	1,300 (59)
1985 (e)	1,500	–	–	1,500 (50)

SOURCE JAPAN SOCIETY OF NEWER MATERIALS

With growth like that in sight, and the likelihood of expanding markets for specialized devices, the study group, which included all major Japanese silicon makers, concluded that a massive buildup of both technology and production capability is essential. Moreover, the report warns, because Japan consumes 48% of all high-purity silicon in the noncaptive world market, "foreign makers are implementing plans for full-scale entry into the Japanese market."

Within 12 weeks after the MITI report was released last March, three major Japanese steel companies, eager to diversify their stagnating operations, announced plans for new startups in either wafer or poly production. The most formidable new player is New Japan Steel Corp., which has forged a link between its new silicon subsidiary, Japan Steel Electronics Corp., and Hitachi Ltd., both of Tokyo. Hitachi already has provided equipment and engineering staff for a startup, with plans to produce 2 million 5- and 6-in. wafers annually beginning in April 1987.

Other tieups include Kawasaki Steel Corp.'s purchase of Santa Clara, Calif., wafer producer NBK Corp., which it used to forge a Japanese production and marketing link with LSI Logic Corp.'s Japanese subsidiary, Nihon LSI Logic Corp.; Nippon Kokan Corp.'s purchase of General Electric Co.'s Great Western Silicon Co. poly production technology and factory in Chandler, Ariz.; and Toyo Soda Corp.'s purchase of wafer fabrication technology from Siltec Corp., Menlo Park, Calif. Showa Denko Corp. has made a deal to purchase Sony's silicon-wafer production technology and become a supplier, according to industry sources, but neither party will divulge details.

Although the foreign makers acknowledge the ability of the Japanese to become formidable factors in the silicon market, Wacker's Freiesleben, himself a chemist, has strong doubts about the time period the new players have set for themselves.

"The [New Japan Steel] objective of being in operation by 1987 is simply unrealistic," says Freiesleben, who was in Tokyo recently to continue talks with potential partners for Wacker's Japanese production plans. "The technical requirements that a company must meet to enter this market are extremely demanding. We are talking about chemical-purity ranges of parts per trillion, and mechanical accuracies of 1 μm or less. I would deem it a brilliant achievement if the Japanese could produce by 1995 what they plan to produce by 1990."

Wacker, which claims from 45% to

50% of the $200 million world poly market, has begun joint-venture talks with at least four Japanese companies. The plan is for a fully integrated silicon operation, starting with the construction of a poly plant by no later than 1990, to be followed by wafer production within two to three years.

Freiesleben's strategy is based on Wacker's very strong technological position. ("About the only companies in the world who are any good at making polysilicon are Wacker and Dow Corning," says an industry executive). Wacker expects to announce its new venture by next summer, almost surely with a Japanese partner that is worried about survival in a more competitive market.

Japan's leading wafer producer, Shin Etsu Handotai Co. (SEH), is not worried about survival. But like the foreign makers of polysilicon and silicon wafers, it fears that overproduction and excessive competition will squeeze profits for everyone. "It is going to take these newcomers at least four years to improve their technical capabilities to the point where they can be said to be competitive with us," says Nobuyoshi Ogino, director of the office of the president for SEH. "It takes us one year just to prepare the proper specifications for a new product, and we've been in this business for decades."

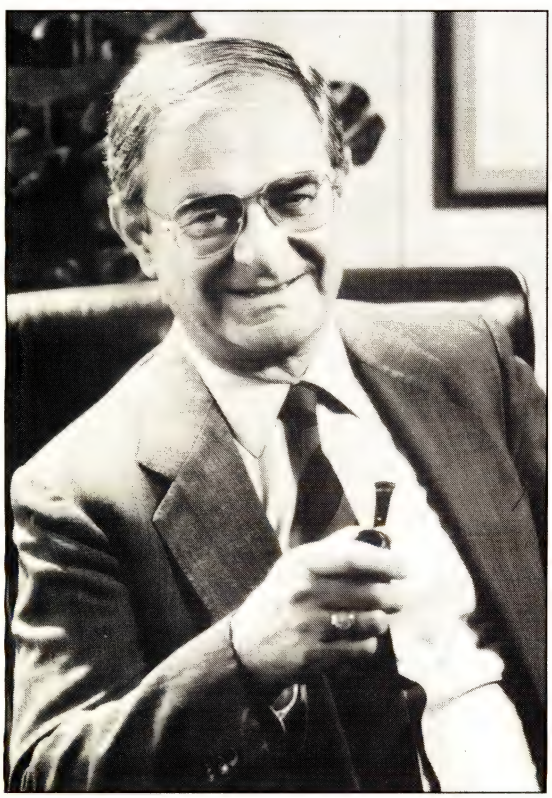
Nonetheless, Ogino has no doubt that some of the newcomers will develop into formidable competitors, "and when they do, there will be severe conditions for all of us." To add to the difficulties, he also fears that the cyclical semiconductor market may be in for another of its downturns in the late 1980s.

Dow Corning, which sells poly in Japan through a subsidiary, Dow Corning Japan Ltd., has no plans to change its marketing structure. "We shall continue to import from our U. S. production plant," says Hiroshi Hotta, acting general manager of Dow Corning Japan's New Venture Business Division. He says Japanese polysilicon makers are increasing capacity and will more than double their 1985 production of 1,340 tons. Actual market demand this year will be about 2,400 tons, Hotta says, and will pick up next year. But the ultimate issue remains whether the Japanese can produce poly that meets the quality levels of the two major foreign suppliers.

PUSH COMES TO SHOVE. "There is no question that MITI is pushing these new ventures along with the hope that one or two of them will flourish," says another industry executive. "There also is no question that two or three, or maybe more, are going to go under." The NKK purchase of what one industry engineer calls "outdated GE technology" makes that venture one of the most questionable. The New Japan Steel-Hitachi link for wafer production as well as ties between Tokuyama Soda Corp. and Toshiba Ceramics Corp. in polysilicon production are seen by industry sources as likely winners in the future.

The survivors, market analysts predict, will be forced in some cases to seek new strategies. "SEH has strong technology, but the tieup between Japan Steel and Hitachi is going to hurt SEH because they are a major wafer supplier to Hitachi. They're going to have to gear up their operations in the U. S. and Europe to compensate for the market share they're going to lose in Japan," says one executive.

Monsanto, which has made such a major commitment to its new Japanese wafer plant, also faces severe problems, say Japanese industry sources, because customer specification demands in Japan are far more strenuous than anything Monsanto has faced in the U. S. "We recognize this challenge," says Monsanto's Cook, "but we were among 60 companies given an award last year by NEC Corp. for reliable service. That's more than a piece of paper; it means NEC believes we're for real." □



TURNAROUND. Freiesleben of Wacker Chemicals had to restructure his approach to selling polysilicon.

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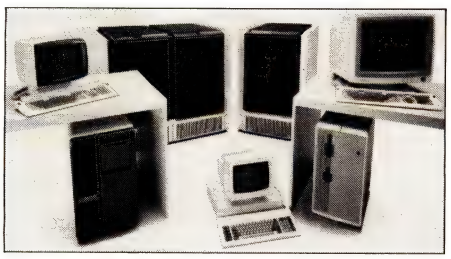

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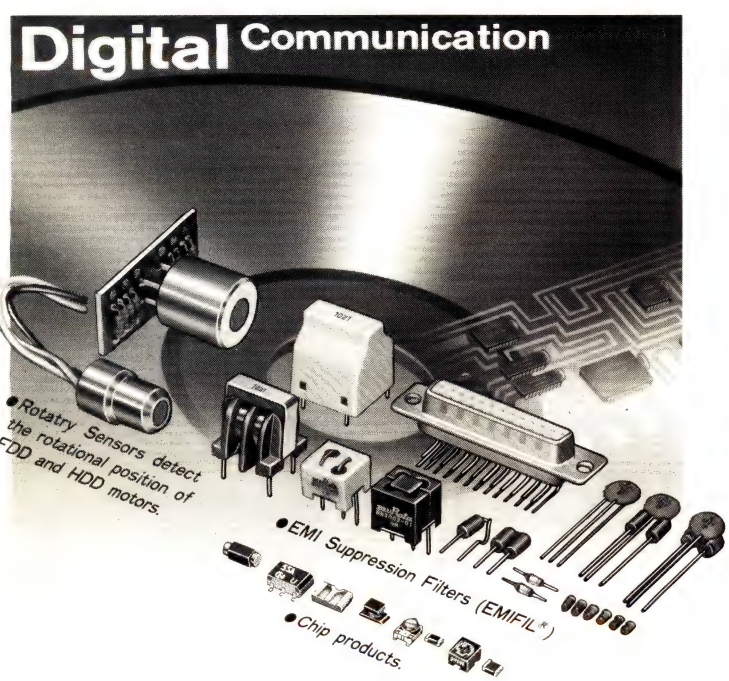

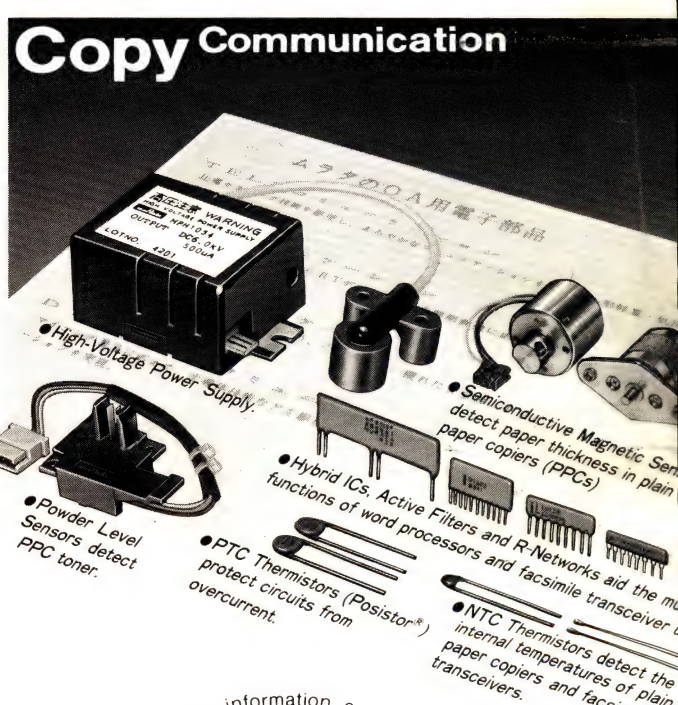

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IT'S THE BEST OF TIMES FOR ¼-IN. TAPE DRIVES

BUT MARGINS ON DISK BACKUPS ERODE AS COMPETITION EXPLODES

by Larry Waller

LOS ANGELES

Perhaps the happiest faces in the computer business these days belong to the people making and selling streaming-tape cartridge drives for personal computers. Despite a slowdown in the overall market, the backup memories are booming. The ¼-in. tape drive is fast carving out a niche as the principal memory-backup medium for microcomputers. At last month's Comdex/Fall '85 in Las Vegas, they could be found in most new hardware.

"The world has now adopted the ¼-in. cartridge," pronounces Lee H. Elizer, a vice president of Freeman Associates Inc., a Santa Barbara, Calif., consulting company that specializes in the tape business. But as fast as this business is growing, it will not be fast enough to support would-be suppliers. A host of ambitious competitors worldwide, scenting a hot product, are elbowing into the action: Elizer counts nearly 20 now.

For makers of the newly ubiquitous drives, the big problem will not be to sell them; it will be profit margins. "Now the only question left is who makes money," Elizer says.

At least two cartridge manufacturers are finding the current success particularly sweet, however. Archive Corp., Costa Mesa, Calif., and Cipher Data Products Inc., San Diego, have been proclaiming cartridge tape as the inevitable main backup medium for microcomputer disk memory since the early part of the decade.

Other market leaders include Rexon Inc.'s Wangtek subsidiary, Simi Valley, Calif.; Kennedy Corp., Monrovia, Calif.; and Tandberg Data Inc. of Anaheim, Calif., which is closing in fast on the others. But another player is Irwin Magnetics Systems Inc., an Ann Arbor, Mich., company whose main product is a smaller 0.15-in. tape drive.

The market for these tape-cartridge backups did not come easily. It took several years for customers to see the product's potential, and despite aggressive marketing during the 1982-84 period, nothing much happened. The major factor was that the companies failed to realize how difficult it can be to sell a new technology for a unique application.

"We were pioneers," recalls Archive marketing vice president M. Thomas Makmann. "But that meant convincing customers that the technology was real and they needed it." In retrospect, he and his peers admit they wildly overestimated how fast the backup devices would sell initially—not unusual among entrepreneurs in high technology. Some early market projections predicted that production by individual players would reach levels that the entire market still has not attained.

Tape cartridge is now backup standard for personal computers

From the customer's viewpoint, the big factors that barred early acceptance were that no major maker pushed the drives, and no heavyweight computer manufacturer lent legitimacy to the new technology by signing a large contract. From the perspective of the computer makers, the logic was inescapable: users had not yet seen the need for backing up data from personal computers whose memories were no larger than 10 megabytes.

"If they did go for backup, it was not too hard to use a floppy disk," points out Elizer. The crossover point came when multiuser microcomputer systems became important, and 5¼-in.-disk memory sizes swiftly grew past 20 megabytes. By then, floppy disks were too small, too slow, and too unwieldy to depend on.

But the most telling early damage to early efforts to market the ¼-in. backup drive was inflicted by the manufacturers themselves: they could not build reliable products in volume, as they initially promised. "They were not as easy to build as first thought," says Larry D. Hemmerich, general manager of Cipher's Applied Systems Division.

Start/stop technology developed for ½-in. tape often did not translate into dependable hardware to handle the narrower medium racing through the read/write head at 90 in./s. Although most drive makers denied having such production problems, their competitors were more than happy to provide the information for prospective customers.

"No manufacturer had his act together," flatly states Whitney Lynn, Wangtek marketing vice president. Furthermore, until the industry got together and hammered out a standard, there was confusion over incompatible interfaces.

But the product began to take off in 1984, right in the middle of the computer industry's recession. The reason, simply enough, was that a sizable number of small-computer users, along with original-equipment manufacturers and especially add-on peripheral suppliers, finally came around to the view that any machine with more than 20 megabytes of memory indeed must have a fast reliable backup scheme—exactly the message that tape-drive makers had been

DISK-BACKUP MARKET FOR SMALL TAPE (in thousands)

Medium	1983	1984	1985	1986	1987	1988
Cassette						
more than 5 megabytes	3	13	38	53	71	93
Minicartridge						
more than 5 megabytes	–	41	139	217	364	564
Cartridge						
20 to 80 megabytes	84	227	420	713	936	948
more than 80 megabytes	–	2	4	13	35	63
Total	87	283	601	996	1,406	1,668

SOURCE: FREEMAN ASSOCIATES

BACKUP. Archive's Scorpion ¼-in. tape drive comes in 20-, 45-, and 60-megabyte capacities.

trying to sell for three or four years. And drive suppliers had finally begun to produce enough reliable product to meet this demand.

Now the drives have evolved into slickly packaged units in the half-height 5¼-in. disk-drive form factor with more similarities than differences among products from different manufacturers. "The products are really not all that different," confides an industry insider, who asked not to be identified. Most suppliers have a full line of drives, divided among models for differing capacity and performance requirements of customer equipment.

For example, nearly all play up the ease of a supposedly proprietary mechanical design for loading the tape cartridge (manufactured by 3M Corp.) into the device. Typical is the claim for simplicity of operation that Kennedy makes for its model 6500. And the critical interface question was virtually settled when all the leaders fell into step behind the quarter-inch-compatibility standard.

Archive's Sidewinder and Scorpion models employ the QIC-02 and upgraded QIC-2¼ interface standards, as does Wangtek's series 5000E, which adds the further expanded QIC-36 to its basic drive. These best sellers come in the common 45- and 60-megabyte sizes and perform at the 5-megabyte/min data-transfer speeds needed by multiuser systems.

SMALLER, SLOWER. Smaller-capacity drives for backing up single computers, in the 10- to 20-megabyte size, can run at the slower 1-megabyte/min rate. Cipher's popular series 525 FloppyTape drive is an example, as is Irwin Magnetics' somewhat faster Backup unit.

With the backup drives enjoying rapid acceptance and suppliers busily signing up customers, pricing is becoming the big issue. No company wants the public reputation of pacing the downward spiral of prices, but competitors point fingers at the two leaders, Archive and Wangtek. In big volume to OEMs, the per-unit tab has dropped to about $350 for a typical drive, far below the $800 to $1,000 quoted in 1982.

This trend toward price-cutting brings up the profitability question and how this will affect a small company's ability to finance production growth and support improved product development. "If a company is not making money, can they continue to make investments?" asks Cipher's Hemmerich. Archive is a particular target, because it leads in sales and has no other business to fall back on.

OEM prices drop in half in three years

Archive's reply is to underline its $150 million in new business over the past year. Furthermore, the Costa Mesa company could end up with the lion's share of the disk-backup market, which Freeman Associates pegs at some 420,000 cartridge units of 20 to 80 megabytes for 1985 (table, p. 59).

Freeman does not break down its figures by individual company, but industry consensus ranks Archive clearly on top, followed by Wangtek and Cipher. Kennedy and Tandberg Data round out the top five—for now. (Irwin Magnetics, which shipped its 100,000th unit last month, is in the minicartridge class of 5 to 20 megabytes.)

All hands also agree that new products and new competitors will keep the heat on the leaders. Evidence of the coming free-for-all surfaced at Comdex, as Tandberg Data surprised its peers by an attempt to leapfrog their drives with its model 3315, a 120-megabyte drive that will sell for only 25% to 30% more than a 60-megabyte unit. Tandberg, the

Norwegian company that has been in the U.S. market only since January, makes no bones about going after a share in the U.S. backup market to match the 50% it has in Europe.

Cipher, whose main strength is in ½-in. tape, made its move by pulling an end-around on its Comdex-bound competitors. At the first of a series of private showings in Boston, it unveiled a family of ½-in. drives that use IBM Corp.'s 3480 cartridge medium, initially in a 200-megabyte capacity.

Competitors, which had expected ½-in. cartridges soon, were not slow to cast a few doubts. "Very strange," comments Russell Bartholomew, Kennedy's marketing vice president. He notes that the new Cipher product line does not have the expected higher speed and capacity, and largely parallels ¼-in. performance. He and others think Cipher can't make hay with what he calls such "low-ball specs." Cipher counters that the new ½-in. cartridge offers the best upgrade of ¼-in. models, and adds that any criticism comes from companies that don't have one.

Other Comdex developments in backup tape drives include a proliferation of units for next year using the new 3M DC-2000 tape cartridge. The DC-2000 is cheaper than the present medium, and 3M announced it has a drive ready. The Minneapolis company intends to license the hardware to other manufacturers to stimulate cartridge sales, sources agree. And 3M launched a promotional effort extolling the benefits of cartridge tape.

GOOD YEAR SEEN. For now, all hands see strong growth through the next year, though Archive's Makmann thinks competition will toughen considerably within six months. Freeman market projections are more encouraging, showing no flattening through 1988. But other crystal balls start to cloud over well before that, and planners are already feeling uneasy.

"It's appropriate to be nervous, because this industry moves so fast," explains Edwin F. Carlson, president of Irwin Magnetics. Key questions center on how fast Japanese companies can gain a foothold in the U.S. and how rapidly the most feared alternative backup technology, optical disks, comes along. So far, the potential Japanese competitors have not been able to get up to speed because they lack a backup business at home.

As for the looming presence of the optical disk, the consensus among tape people is that it will become a threat only when erasability is possible, which is several years distant. Summing up a prevailing opinion is Archive's Makmann. "I'll give it [optical disks] the decade of the '90s, but the rest of the '80s belongs to ¼-in. tape." □

NORSK DATA GROWS FAST BY GOING PAN-EUROPEAN

SUPERMINICOMPUTER MAKER USES JOINT VENTURES AND NEW PRODUCT STRATEGIES TO MOVE OUT OF HOME MARKET

OSLO, NORWAY

The individual markets of Europe are usually big enough to support small niche-oriented companies that dominate in their home countries. But to be a major player in the electronics industry requires a breadth that many of these small companies are unable—or unwilling—to adopt. Norsk Data AS, the superminicomputer maker in Oslo, believes it has managed the tricky transition from just a Scandinavian operation to one with footholds in the major European markets. "The company is gaining share in all major markets in which it operates," says chairman Terje Mikalsen. "In particular, the growth in new orders has been very strong in France, the UK, Norway, and Denmark."

By broadening its base of operations out of Scandinavia into the rest of Europe, and by pursuing a strategy of technical collaboration with electronics companies on the Continent, the company is flourishing at a time when many of its rivals—especially in the U.S.—have stubbed their toes. "The company is heading for substantial midterm growth," says Peter Roe, a market analyst with Hoare Govett Ltd., a London brokerage. Norsk Data's performance should continue to be impressive, growing 30% to 40% a year, believe analysts at Robert Fleming & Co., another London brokerage.

As many U.S. computer companies fight to prevent slower sales from devastating their profits, Norsk Data is growing so fast that it is seeking to postpone some deliveries—and hence profits—until next year. The company wants to smooth its growth from 1985 to 1986, and is asking some customers if deliveries can be deferred till then.

Even with such a strategy, profits for the year will jump 71%, to $48 million; sales could jump 49%, to $270 million, sources estimate. In 1984, Norsk earned $28 million on sales of $181 million.

PACTS HELP. Norsk Data is also busy on the technology front. It has entered into collaborative accords with France's Matra group to develop a high-performance vector processor for scientific applications and with Racal Electronics Ltd., Bracknell, England, to develop a Zeta-Lisp engine for supporting fifth-generation computer uses.

The driving force behind Norsk Data is its president, Rolf Skaar. Skaar set up Norsk in 1968 with two colleagues who have since left the company. His idea was to produce a new generation of high-performance minicomputers for industrial and scientific use.

That strategy had one flaw, however: marketing. Norsk Data at first was technologically driven rather than market-led, a pitfall in which many high-tech companies find themselves. Typically, such companies believe their technology is so good that the products will sell themselves. Norsk Data's hardware sold well to sophisticated users such as the European Nuclear Physics Research Organization, but it did little to push sales to less sophisticated commercial customers. Its first 32-bit superminicomputer, the NORD-5, was a technological success but a commercial disaster that finally had to be dropped.

Norsk Data's marketing weakness became obvious in 1976, when sales flagged badly. Skaar won an internal debate on the company's direction and immediately gave marketing equal status with research and development. He set up committees in which both R&D and marketing staff members could discuss product strategies. The aim was to move more strongly into the commercial market.

PARITY ACHIEVED. The move succeeded. Technical and scientific systems are now roughly equal to transaction-processing and office-automation systems in hardware sales, says Lars Gahnstron, vice president of marketing for the UK and Central Europe.

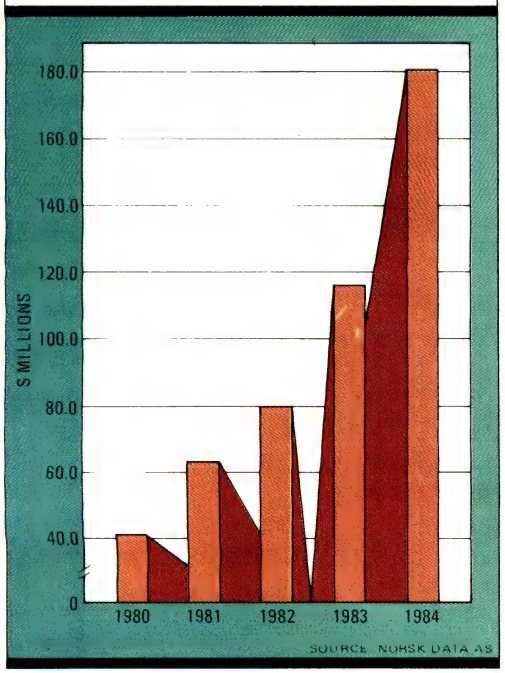
"We spent a lot of time trying to find out what will be the market niche of the future," says Skaar. "We try to develop information systems that mirror the organization they are used in. We didn't bet our souls on the personal computer. Instead, we focused on supporting the [office] group, providing them with the shared information they need by means of an interactive data base."

In line with this policy, Skaar also shifted R&D emphasis more deeply into software. This area now accounts for 75% of Norsk Data's R&D funds. "We were one of the first companies to make such a switch," he claims.

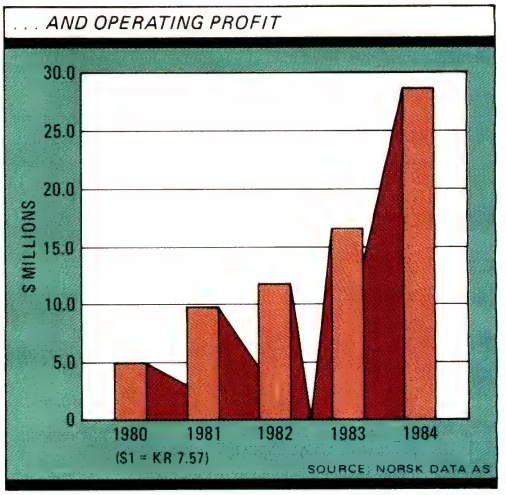
Skaar believes two factors have contributed to help Norsk Data's technology. The first of these is "the ability to rely on your own beliefs and not to follow what is preached in industry." The second is Norsk Data's small size. The larger an organization is, the slower it can react to market developments, he says. At Norsk Data, product-development times are typically 18 months, compared with up to four years for larger companies. To maintain flexibility, the company subcontracts all board manufacture and component insertion and carries out final assembly and test in-house.

Norsk Data introduced a time-sharing minicomputer in 1971, and in 1972 it launched its first, ill-fated 32-bit superminicomputer. In 1975, it was the first company to run a Codasyl data-base management system on a minicomputer. Then in 1983, it reentered

NORSK DATA: STEADY GROWTH IN REVENUE . . .



. . . AND OPERATING PROFIT



DRIVING FORCE. Rolf Skaar is president and founder of Norway's Norsk Data.

the 32-bit market with its ND-500 family. Norsk Data claimed this general-purpose machine was the world's most powerful superminicomputer, having a performance of 7.1 million Whetstones.

In designing its various lines of computers, Norsk Data has "taken great care to preserve our investment in software," Gahnstron says. Norsk Data early adopted a virtual-machine architecture, to which the operating system and applications software could be targeted.

At the same time, the underlying hardware can be changed without disturbing the operating software. The same operating system spans both 16- and 32-bit machines. The ND-500 is a "soft," or heavily microcoded, machine—meaning that languages such as ZetaLisp can be executed in hardware.

To ensure its long-term survival, Norsk Data needed to become a pan-European company. Without the resulting economies of scale it could not compete with its larger U. S. rivals.

Unlike a U. S. computer company, which can develop a single application for the home market, a European maker must be able to adapt its software and systems to each country's local market. Norsk Data has learned to use the Continent's fragmented market to its advantage. "Norsk Data's systems are not the cheapest, but they are the most flexible," says Skaar. This flexibility comes through the company's software, which can be tailored quickly to meet the individual needs of customers.

UK CONNECTION. In May 1984, Norsk Data set up Racal-Norsk Ltd., a joint venture with Racal Electronics. The Fleet, England, company, which is 51% owned by Racal, was founded as a European supplier of expert knowledge-base hardware. Its first product, the KPS-10, is based on Norsk Data's ND-570 computer, microcoded to support ZetaLisp. Racal has a UK license for the language, which was developed at Massachusetts Institute of Technology.

In West Germany, the company purchased its former distributor, Dietz Computer Systems, and rechristened it Norsk Data GmbH. It retained that company's computer-aided-design and -manufacturing applications software but dropped its hardware line.

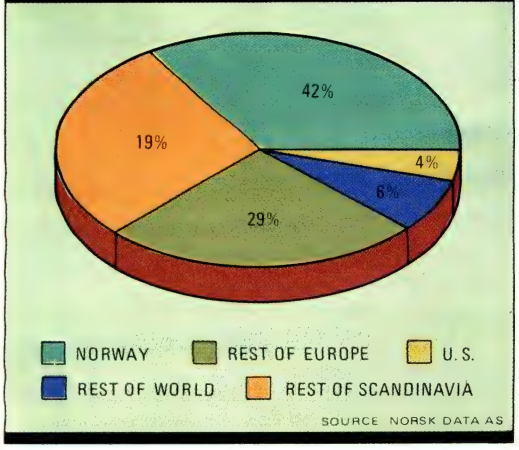
In France, after making little headway, Norsk Data sold its sales operation to the French Matra group in 1984. Matra now sells Norsk Data systems under its own logo. "Matra turns out to be a very good partner," says Gahnstron. "They have had a fantastic success. It is amazing the kind of business you can do in France." Matra, with interests in office automation, robotics, and defense and space systems, has unlocked doors to the French government and defense market, Gahnstron says. It also provides complementary skills in very large-scale integration design and software.

The two companies are also jointly developing a high-performance vector processor with funds from Eureka, Europe's technology-support initiative. Based on Norsk Data's ND-500, the machine is expected to perform 100 million floating-point operations per second for signal processing as well as seismic and other computations, and would take the two partners into an untapped market sector.

Norsk Data now has a solid European foothold, believes Hoare Govett's Roe. He says profits from its European operation will more than double this year and next.

With such a rich European seam to tap, the U. S. market is not high on Norsk Data's list of priorities, executives say. But when it does enter the U. S, it will likely do it by linking with a local partner. *–Kevin Smith*

EUROPE IS KEY TO NORSK DATA'S BUSINESS



BOTTOM LINES

PC SALES TO BE HOT THIS HOLIDAY SEASON

It could be a greener Christmas selling season this year than last for makers and distributors of personal computers, says Dataquest Inc. The San Jose, Calif., market researcher says sales could be as good as—and maybe better than—those of Christmas 1984. Among the reasons for this, Dataquest says, is that consumers have been conditioned to wait for Christmas discounts and promotional sales before buying. Also, consumers believe the MS-DOS-type architecture will continue to be the industry's mainstream product, which means that they will not delay hardware purchases. Price cuts by Apple Computer Inc. and IBM Corp. could also spur sales.

LEE DATA BUYS DATASTREAM

Lee Data Corp. has agreed to acquire Datastream Communications Inc., a privately held company in Santa Clara, Calif. The Minneapolis maker of multihost windowing terminals and personal work stations says it will pay Datastream shareholders $3 million in cash plus a percentage of Datastream's revenue for two years, as well as warrants to buy 500,000 shares of Lee Data stock. Datastream, a maker of products that extend and integrate computer networks in the IBM Corp. 3270 environment, had revenue of about $7 million in fiscal 1985, ended June 30.

LASER-OPTICS MAKER RAISES $5.8 MILLION

Reference Technology Inc., the Boulder, Colo., supplier of laser-optic equipment, said it has raised another $5.76 million in venture financing. This brings its funding to almost $24 million, according to the company. Reference Technology said the new funds will be used primarily as working capital and to support new sales and marketing efforts.

INTELCO GETS $1.5 MILLION IN FUNDS

Intelco, a startup that offers automatic test equipment for the telecommunications industry, has received $1.5 million in venture-capital funding. The West Acton, Mass., company says it plans to uses the funds to expand engineering, marketing, and manufacturing operations. Intelco says it now ships two fiber-optic test instruments, and it plans additional products in 1986.

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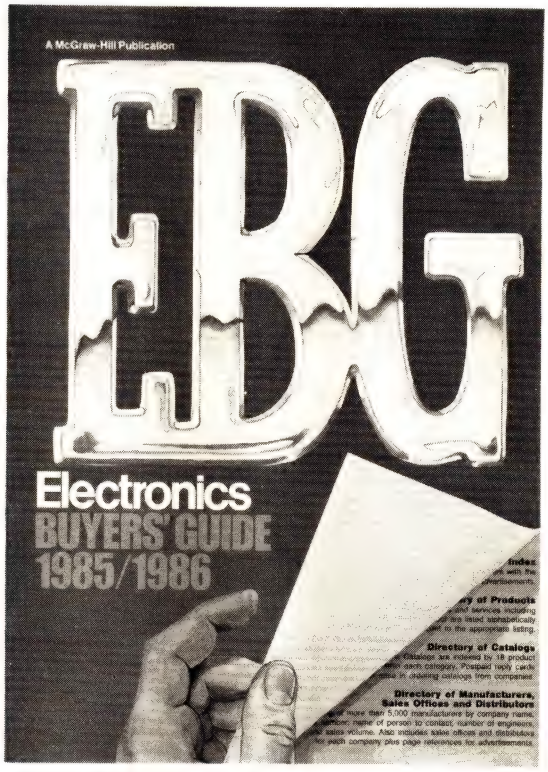

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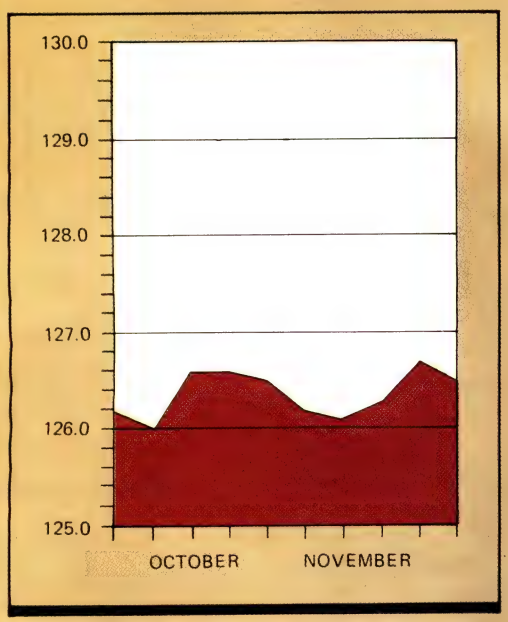

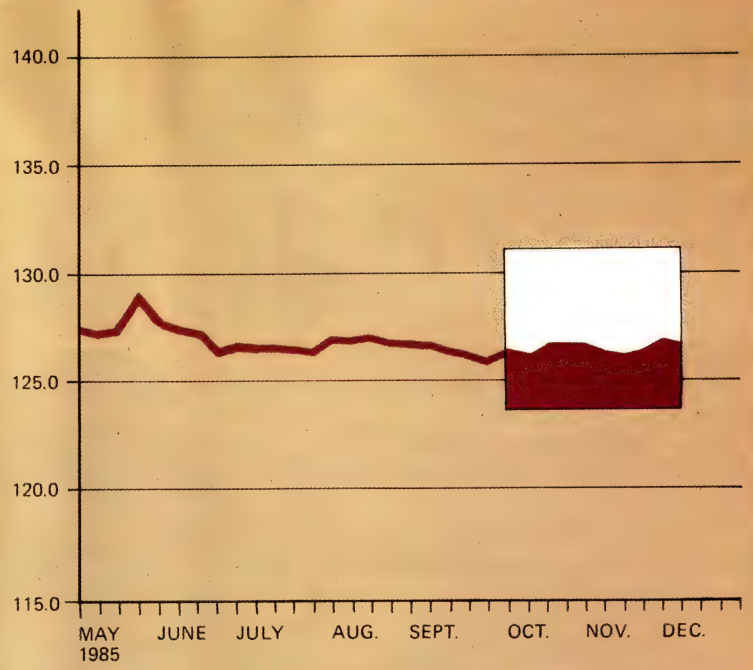

THIS WEEK	= 126.5
LAST WEEK	= 126.7
YEAR AGO	= 129.8
1982	= 100.0

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U. S. ELECTRONICS SHIPMENTS

Shipments ($ billions)	October 1985	September 1985	October 1984
Communications equipment	5.247	5.562	4.638
Radio and TV receiving equipment	0.987	0.900	0.889
Electronic and electrical instruments	4.621	4.606	4.428
Components	3.169	3.104	3.825

U. S. GENERAL ECONOMIC INDICATORS

	October 1985	September 1985	October 1984
Index of leading economic indicators	171.1	170.6	164.2
Budgeted outlays of the federal government ($ billions)	85.074	73.191	81.037
Budgeted outlays of the Department of Defense ($ billions)	21.942	21.498	20.643
Operating rate of all industries (% capacity)	78.1	78.4	79.2
Industrial-production index	124.9	124.9	122.7
Total housing starts (annual rate in thousands)	1,760	1,589	1,564

A 1% slide in shipments of U. S.-made electronic equipment in October caused the *Electronics* Index to dip a bit in the latest week. But the statistics held some good news for U. S. manufacturers in that most of the decline in shipments came from just one sector: communications-equipment shipments dropped 5.6%. All other segments of the U. S. electronics industry reported that shipments rose in the month.

Shipments of radio and TV equipment racked up a boisterous 9.7% increase in October, bringing the year-over-year gain to more than 11%. In contrast, shipments of instruments inched up a sluggish 0.3% in the latest month and only a modest 4.4% from October 1984. The beleaguered components industry got some good news in October: shipments rose 2.1% over September. But component shipments are still down 17% from October 1984.

With the overall economy still dragging, it is doubtful that Ocober's gains in shipments in most segments are signs of the beginning of an industrywide upturn. Rather, shipments of electronics will probably alternately grow and contract for a while.

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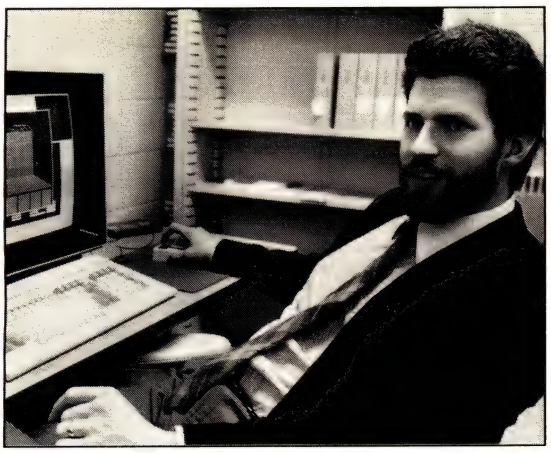
ILLINOIS' WHITE OPENS A PC WINDOW TO CRAY

CHAMPAIGN, ILL.

Getting the most out of a supercomputer typically requires an expensive engineering work station and a user with sophisticated graphics expertise. But Larry White—in collaboration with IBM Corp.—is out to change all that.

As the manager of workstation projects at the National Center for Supercomputing Applications, run by the University of Illinois, White is the point man in a joint study with IBM to develop the IBM Personal Computer AT as a front-end work station for the center's Cray Research Inc. X-MP/24 supercomputer.



CONNECTOR. Larry White will link PCs to supercomputers.

White sees a pressing need for this kind of capability. "General Motors has a Cray and something like 10,000 PCs throughout the company. But up to now, the PCs couldn't talk to the Cray."

By developing the popular PC AT for use as a window to a Cray, White hopes to help open up the supercomputing field to more users. Supercomputers today are most commonly accessed with a dumb terminal, which usually provides no capability for graphics—an important tool for interpreting a supercomputer's output. Through the PC AT, White says, "We want to bring this capability to the average scientist."

Under terms of the three-year study announced last month, IBM will provide the center with more than $500,000 worth of equipment, including 30 PC ATs loaded with MS-DOS and Xenix operating systems and Topview windowing. White's contribution will be to develop a package of easy-to-use, scientific work-station software for accessing the Cray with the PC AT. The software set will be used by visiting researchers at the center and will also be made available to the general research community.

The center will open its doors next month with funding from the National Science Foundation, the state of Illinois, the university, and corporate grants. Officials expect to host about 1,000 researchers during its first year of operation.

WELL-GROUNDED. At age 30, White has already built a broad base from which to attack the PC-to-supercomputer software task. As the president of his own company, White House Software Inc., formed in 1980, White has written, sold, and supported software for multiuser 68000-based work stations. He also has experience on IBM PCs and compatibles, gained at Leading Edge Products Inc. of Needham, Mass., where he worked as manager of software development and consulted for 2½ years before taking his current job in October.

White has additional experience in Unix-based systems from an earlier job, and at the California Institute of Technology, where he put in 3½ years toward a doctorate in computer science, ending in 1980. A native of the Chicago area, White earned his bachelor's and master's degrees in the same discipline from the University of Illinois.

The deal with IBM calls for the center to locate and integrate commercially available software for efficiently linking the PC AT to the Cray. "For

PEOPLE ON THE MOVE

ANDY PROCASSINI

☐ Veteran semiconductor marketing executive A. A. (Andy) Procassini will succeed Thomas D. Hinkelman as president of the Semiconductor Industry Association. Both men were part of the "Hogan's Heroes" migration of 1969, in which a dozen executives moved from Motorola Inc. to Fairchild Camera & Instrument Corp. with chief executive C. Lester Hogan. Procassini spent 13 years with Fairchild. Most recently, he served as marketing vice president for Hyundai Electronics America, the South Korean manufacturer that last fall sharply curtailed its Santa Clara, Calif., U. S. operations.

JAMES A. STAHLEY

☐ Sperry Information Systems Products and Technology, a unit of Sperry Corp.'s Information Systems Group, Roseville, Minn., has promoted James A. Stahley to the new post of vice president for systems development. He will be responsible for product development for Sperry's large- and small-scale and special-purpose computer systems. Stahley joined the company in 1966 and has held various manufacturing and program management positions. Most recently, he served as vice president of Sperry's Air Traffic Control Division in Eagan, Minn.

ROBERT GARROW

☐ A cofounder of Convergent Technologies Inc., Robert Garrow has joined the staff of Sun Microsystems Inc., Mountain View., Calif., as vice president and general manager of Sun's work-station division. Garrow's appointment lightens the load for Bernard J. Lacroute, who has been acting general manager of the division in addition to serving as executive vice president. Garrow first served as vice president of engineering at Convergent and most recently as general manager of its Distributed-Systems Division. He has also served as general manager of Intel Corp.'s Systems Products Division, located in Santa Clara, Calif., and is credited as a co-inventor of Multibus I.

STEVEN B. ENGLE

☐ The new job of general manager and director of Micro Power Systems Inc.'s Telecommunications Division goes to Steven B. Engle, who previously served as the Santa Clara, Calif., company's telecommunications program manager. In his new post, Engle will report directly to company president John Hall. Before joining Micro Power, Engle was a management consultant and one of the founders of Strategic Decisions. He also held management positions at Resource Planning Associates and at SRI International.

ALAN NEMETH

☐ Alan G. Nemeth has been named first corporate consultant at Prime Computer Inc., Natick, Mass. The position is equivalent to a vice president and is the company's highest technical position. Nemeth joined Prime as a principal technical consultant in 1982, having worked previously at Bolt, Beranek & Newman Inc. and at the Lincoln Laboratory of the Massachusetts Institute of Technology. He is a member of a Unix research steering committee at the University of California.

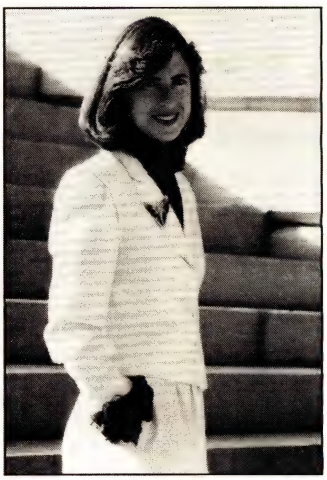
example, we'll be using Crosstalk to get information from the Cray, and we'll use Lotus 1-2-3 to graph it," says White. "We'll do custom macros for Crosstalk to make accessing the Cray simple and straightforward. And we'll write data-conversion routines to take data from the Cray and put it into Lotus 1-2-3 format."

Though the integration of commercial software will satisfy the terms of the IBM contract, "we're planning to go quite a bit beyond that here at the center," White says. *–Wesley R. Iversen*

PROTECTING U.S. FIRMS IS A BIG JOB FOR ITC'S STERN

WASHINGTON

The U.S. International Trade Commission, until recently associated with such esoterica as the impact of Canadian rock salt on the U.S. market, has quickly attracted the attention of the U.S. electronics industry with rulings on cases involving Japanese memory chips and telecommunications equipment. "We have undoubtedly expanded our scope," says chairwoman Paula Stern.



FREE REIN. Stern stresses the ITC's independent role.

The commission has in the past handled cases involving imported TVs, microwave ovens, and even fiber optics. But Stern says the recent spate of international electronics cases has presented new challenges because the U.S. trade laws the ITC interprets aim at protecting domestic industries. "So from the first shot out of the box you have to decide, What is the domestic industry?," explains Stern, 40, who was appointed to the ITC in October 1978.

Stern says determining precisely what constitutes an imported product and which companies are part of the domestic industry is often "very knotty." Most U.S. electronics companies are multinational operations, with some activities such as research, design, and wafer and die fabrication performed domestically and final assembly done overseas.

LAYERS. "There are just layers of involvement that have to be examined carefully to determine whether a firm is part of the domestic industry," she explains. "It is a moving target that we're trying to analyze."

The commission works closely with the Commerce Department's International Trade Administration, but it remains an independent quasi-judicial agency, Stern emphasizes. "It's important to have an independent agency which is not part of the executive branch nor part of the Congress finding facts on these questions, which are highly contentious."

Born in Chicago and raised in Memphis, Tenn., Stern was senior legislative assistant to former Senator Gaylord Nelson (D., Wis.) and worked for the Carter-Mondale transition team before her appointment to the five-member commission. Last year, Stern rose to the ITC's top post, a rotating position. Along with two graduate degrees from Harvard University, she holds a doctorate in international affairs from the Fletcher School of Law and Diplomacy.

Under Stern, the ITC has recently issued preliminary rulings involving Japanese erasable programmable read-only memories and cellular mobile telephones [*Electronics*, Nov. 18, 1985, p. 26, and Dec. 2, 1985, p. 15]. It has also investigated dumping charges filed by Micron Technology Inc. of Boise, Idaho, against Japanese producers of 64-K dynamic random-access memories.

DETAILS. Although the bulk of its work deals with imports ranging from Brazilian castor oil to counterfeit Cabbage Patch dolls, the ITC also rules on patent, copyright, and trademark protection cases that often involve computer hardware and software. "That is the area where we get into very detailed engineering questions," says Stern.

There is talk that the commission's duties could be expanded to hear dumping cases similiar to those filed last summer under Section 301 of the Trade Act by the Semiconductor Industry Association. Though the ITC traditionally has focused on domestic industries and U.S. trade, "we have been called upon increasingly by the President and the Congress to do more and more studies on what's going on overseas in terms of unfair competition," says Stern.

Such decisions could go a long way toward determining whether the Reagan Administration decides to shelter the U.S. electronics industry from Japanese competition. *–George Leopold*

LOOK WHO'S BACK.

ELECTRONICS IS BACK.

WITH THE INDUSTRY'S LEADING COVERAGE OF SEMICONDUCTOR TECHNOLOGY.

Here are just some of the more than 100 articles Electronics published during the first six months of 1985 covering worldwide events in semiconductor technology.

January

Chip to Carry Error-Correct Code

MOS Meets Radiation Challange

Late Definition Cuts Custom Costs

ISSCC: Bigger, Faster Chips in Store

Kelley, as New VP, Oversees Americanization of NEC

SGS Semiconductor Eyes New DRAM Markets

DRAM Makers Gird for 256-K

Voice Checks Wafers

Topology Spots Chip-Market Blips

CMOS Array Breaks 1 ns

February

Semiconductor Veteran Seeks Fairchild's Former Glory

Lasers Fix Dynamic RAMs

Civilian Chips Don Uniforms

Chips Forging Telecom Links

LSI Logic Counts on Sandfort to make its Mark in Europe

Memories Dominate ISSCC

NEC Fashions New Fab Process

RCA's Shoyer to Coordinate VLSI with Sharp

Britons Seek Tolerant Chips

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Sun Rises on New Designs

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British GaAs Chips Go to Market

Mask ROM Rides Again

TIs McDonough Chips Away at Graphics Market

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CMOS Chips Gain EE Memory

Plessey Custom Chips Will Test Themselves

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Ballistic Transistors Fastest Yet

GaAs Circuits on Verge of Medium-Scale Use

Intel Takes Wraps Off 386

Italian VLSI Chip Has the Right Accent

Microprocessor Array Speeds Simulation

TI Enters Bit-Slice Market with 2-Micron Bipolar Chips

National Wins a Place in Twin-Technology Club

One-Megabit EPROMs Invade Disk Territory

AT&T Launches 32-Bit Chip Set on Open Market

Chip Meshes 8- and 16-bit Formats

May

US Semiconductor Firms Step Up Pace of Deals with Japanese

Molecular Electronics Research Growing Despite Controversy

Speed Record Claimed for GaAs Transistor

Philip's Eurom Chip Finally Debuts

Darpa Eyes 100-Mips GaAs Chip for Star Wars

Custom-IC Conference Reflects Significant Gains for System Designer

New High-Speed CMOS Chips Vie with Fast ITL

UV-Write-Enable Memory Enhances Logic Chips

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Hitachi Set to Ramp Up 64-K Bipolar-CMOS Chip

Crowd of Hopefuls Warms for 32-bit Microprocessor Race

EEPROM Technology Seeds Reprogrammable Logic

Optical Lithography Gear Keeps Pace with New Demand

Tunneling Nitride Gate Suits Fast VLSI Chips

Chip Makers Map Plans for Factory-Net Boards

Motorola in Bold Bid for MOSFET Lead

SLIC Chip Shrinks Phone-Line Interfaces

Digital Signal Chips go Semicustom

SHOULDN'T YOU BE BACK?

NEW PRODUCTS

SUPERCOMPUTING POWER COMES TO THE DESKTOP

CSP INC. COMBINES ARRAY PROCESSOR WITH MICROVAX II

Until now, array processors, which deliver very fast vector and array calculations, have been tied to host computers that must be shared by several users. Now, by mating a fast array processor with a powerful microcomputer, CSP Inc. can offer what amounts to a personal supercomputer [*Electronics*, Dec. 9, 1985, p. 15].

The Billerica, Mass., company is introducing two versions of its Maxim line—the Maxim/32, with a 32-bit array processor (see diagram), and the Maxim/64, which uses a double-precision 64-bit array processor. Integrating its array processors with a MicroVAX II superminicomputer from Digital Equipment Corp., CSP delivers scientific processing in two affordable, easy-to-use, stand-alone products.

DEDICATED PROCESSOR. Array processors are special-purpose computers that perform calculations with numbers expressed as arrays much faster than general-purpose processors can. By dedicating an array processor to a single user, CSP's Maxim family provides users of scientific computers the personal interactive access to high-speed vector processing. With a personal number cruncher, the researcher can have hands-on control of the computing.

"The new Maxim series is designed for the researcher who needs timely answers to reiterative questions," says Sam Ochlis, CSP's president. "For example, a scientist studying a vast amount of data—and changing one or two variables—needs a machine that can process data very quickly, but leaves him the flexibility of change."

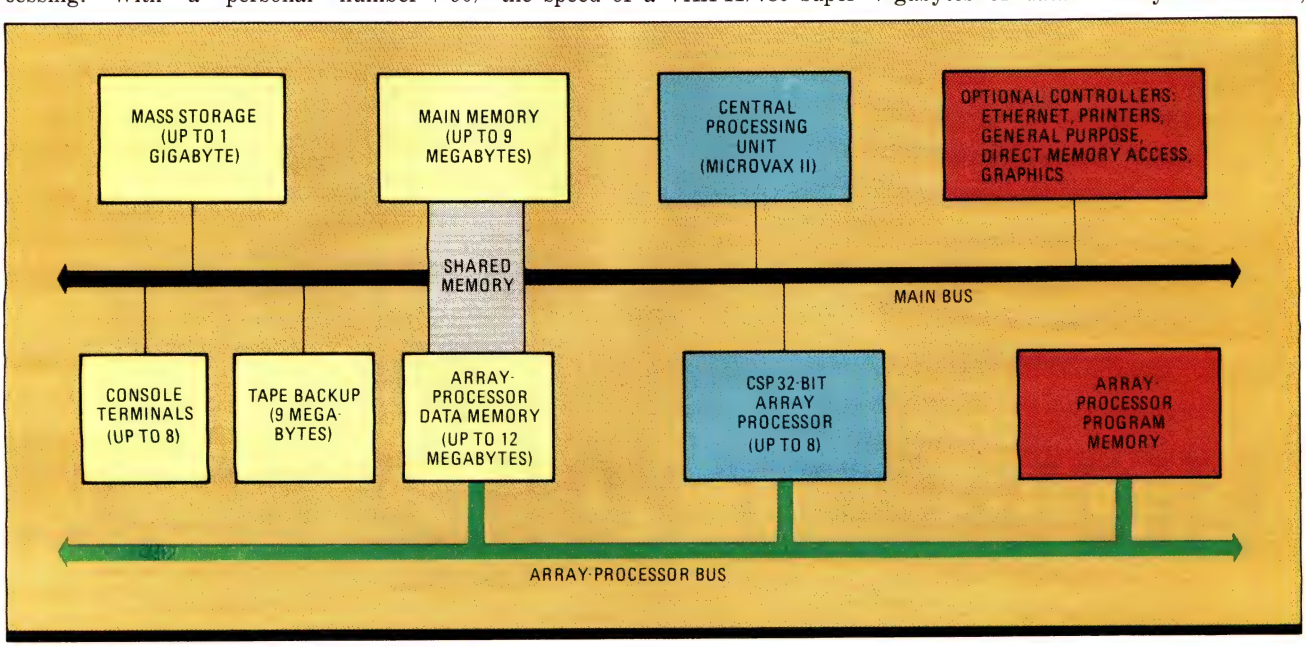
Because the Maxim/32 and Maxim/64 are each teamed with a MicroVAX II and use the VAX VMS operating system, users can also take advantage of the large base of applications software available for VMS systems. Engineers and scientists do a lot more on computers than simply crunch numbers.

The Maxim machines, because they are general-purpose superminicomputer work stations as well as number crunchers, can prepare documents and reports, handle data bases, graphics, and personal-productivity programs, and access other computer services through network connections.

The MicroVAX performs general-purpose computing tasks at about 85% to 90% the speed of a VAX-11/780 superminicomputer, which is rated close to 1 million instructions/s. When the Maxim's array processor comes into play, the vector-processing performance ranges from 5 to 500 times that of an 11/780, depending on the problem. Because the array processor shares a portion of the MicroVAX's main memory, it can access the memory as if it were its own, boosting processing speed.

VAX AND VMS. For this level of personal computing performance, CSP will charge $65,000 for a Maxim/32 and $165,000 for a Maxim/64 in the basic configurations. Both systems come with a MicroVAX II CPU, 5 megabytes of main memory, the MicroVMS operating system, VMS Fortran, a cross-compiler developed by CSP to compile VMS Fortran programs for the array processor, and program-development software. Standard peripherals on both models include a 71-megabyte Winchester disk drive, a 91-megabyte streaming tape drive, and a console terminal.

The Maxim/32 has a 32-bit floating-point array processor with 1 megabyte of data memory. The Maxim/64 comes with a 64-bit array processor and 16 megabytes of data memory. In addition,



NUMBER CRUNCHER. CSP ties together its array processor and a DEC MicroVAX II to configure a personal stand-alone supercomputer.

the Maxim/64 comes in a 16-slot chassis with four expansion slots. Main memory and disk storage in both systems can be expanded.

On the Maxim/32, up to a total of eight array processors and terminals can be attached for multiple users. The multiuser configuration shares the CPU among the users but dedicates one array processor to each.

CSP will be aiming for a more general group of customers for the Maxim work stations than the high-end users who typically purchase CSP's array processors. CSP has an installed base of more than 2,000 of its 32- and 64-bit array processors. For customers who already have MicroVAX machines or who prefer to buy them elsewhere, CSP will integrate them into Maxim systems.

CSP has entered into a joint-marketing agreement with DEC for the Maxim series under which DEC will offer the Maxim family to its customers. The Maxim series can be ordered now for delivery in 90 days. *–Tom Manuel*

CSP Inc., 40 Linnell Circle, Billerica, Mass. 01821. Phone (617) 272-6020 [Circle reader service number 338]

AMD ROUNDS OUT ITS 80286 CHIP SET

With the introduction this week of two new peripheral chips—a bus controller and a clock generator/driver—Advanced Micro Devices Inc. will complete its 16-bit 80286 microprocessor chip set.

AMD's 82C288 bus controller brings CMOS to the microprocessor chip set, offering 15 times lower active power dissipation than a similar n-MOS chip. The company is also bringing out an 82284 clock generator/driver, which generates the clock, ready, and reset signals for an 80286 and its peripherals.

Together, the peripherals support 80286-based system designs with performance levels of 8 MHz. The company is planning speed upgrades of the two new peripherals by next spring, offering support for 10-MHz speeds.

The 82C288 bus controller provides address-latch control, data-transceiver control, and standard-level-command outputs for an 80286-based system. The 20-pin chip has separate command outputs for memory and I/O components.

It operates from a single +5-V power supply. In the active mode, the 82C288 has a power dissipation of 40 mW, and standby power dissipation is 50 μW. Similar n-MOS parts have power dissipation of about 600 mW.

LOGIC FOR MULTIBUS. The 18-pin clock generator/driver contains an on-board crystal-controlled oscillator, MOS clock generator, peripheral clock generator, ready synchronization logic for Intel Corp.'s Multibus, and system-reset generation logic. The oscillator circuit for the chip is a linear Pierce oscillator, which uses an external fundamental-mode parallel-resonant crystal. The oscillator's output is internally buffered.

Both peripheral chips are available in volume quantities in either 6- or 8-MHz versions. In 100-piece quantities, an 8-MHz 82C288 bus controller costs $26.80 each, housed in a 20-pin ceramic DIP. An 8-MHz 82284, in an 18-pin ceramic DIP, costs $22.40 each.

About the time it plans to offer the faster versions of the 82C288 and the 82284, AMD will begin shipping a new high-performance 12.5-MHz 80286. The speed upgrade will result from AMD's shrinking its n-MOS-process geometries from 2.0 to 1.8 μm, says Ed Huber, product marketing manager in the Fixed Instruction Processor Group in Austin, Texas.

AMD is also trimming the price on its slowest 80286. In 100-piece quantities, the 6-MHz 80286 will now cost $54 in 68-pad ceramic leadless chip-carriers. In a pin grid array, it will cost $100. AMD's 8-MHz 80286 central processor packaged in a 68-pad leadless chip-carrier sells for $120 each in 100-piece lots. AMD currently offers 6-, 8-, and 10-MHz versions of its 80286. *–J. Robert Lineback*

Advanced Micro Devices Inc., 901 Thompson Place, P. O. Box 3453, Sunnyvale, Calif. 94088. Phone (408) 732-2400; in Texas, (512) 441-6900 [Circle 339]

DEVELOPMENT SYSTEM SUPPORTS AMD CHIP

Help is on the way—in the form of a development system—for users of Advanced Micro Devices Inc.'s Am29PL141 fuse-programmable microcontroller [*Electronics*, Oct. 14, 1985, p. 63]. The MM141 development system, which connects to an IBM Corp. Personal Computer, has all the hardware and software needed to support the chip, including an editor and assembler, writable control store, and real-time emulator and trace. It appears to the PC as a memory-mapped peripheral.

The emulator can be single-stepped or operated continuously, with or without a breakpoint. The user can also specify a starting address for the emulation.

The trace, which is 2-K words by 32 bits, captures the addresses issued to the writable control store, the contents of the internal registers, and external data that the user supplies. Two trace-point registers and a delay counter control the operation of the trace.

The MM141 sells for $4,995 and is available 60 days after receipt of order.

HLA Instruments, Suite 218, 5667 Snell Ave., San Jose, Calif. 95123.
Phone (408) 726-2050 [Circle 381]

SCOPE REACHES 40 MEGASAMPLES/S

The DS-6121 100-MHz digital storage oscilloscope performs 40 megasamples/s. After capture, the scope does multiple-waveform processing including high-speed equivalent sampling, waveform

averaging, and go/no-go judgment.

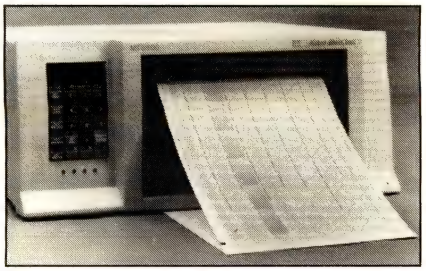
All functions can be controlled remotely over an optional IEEE-488 interface bus. Other options are an RS-232-C interface, to output waveforms to an X-Y recorder plotter, and a seven-memory setup function.

The DS-6121 retails for $5,550. Delivery takes eight weeks.

Iwatsu Instruments, 430 Commerce Rd., Carlstadt, N. J. 07072.
Phone (201) 935-5220 [Circle 366]

OSCILLOGRAPH CAN PRINT 8 CHANNELS

The MT-8500 oscillographic recorder accepts up to eight channels of analog data from the user's system or a plug-in signal-conditioner module, at frequencies up to 500 Hz and amplitudes up to



200 mm. The recorder's response is totally flat, the manufacturer says.

With its flexible channel-expansion feature, the recorder can expand as many as six waveform channels simultaneously to 30 mm for detailed visual analysis. Alternatively, a single signal that measures 20 mm peak to peak can be blown up automatically to one 200-mm channel—the width of the chart paper—without any distortion.

When set to print eight 20-mm waveform channels, the MT-8500 will also print out eight alphanumeric channels, an event channel, and the system channel—18 channels all together. It will also plot any two channels of data in an X-Y format as well as the conventional X-T format. If the MT-8500 is linked to a digitized signal source, it can record up to 30 8-bit digitized channels.

The MT-8500 weighs 38 lb and is available in benchtop or rack-mount configurations. The price of a basic system is $8,200 and delivery is in 60 days.

Astro-Med Inc., Astro-Med Industrial Park, West Warwick, R. I. 02893.
Phone (800) 343-4039 [Circle 367]

SYSTEM DOES DC PARAMETRIC TESTS

The Semtest 150 performs a range of dc parametric tests on semiconductor devices and processes, primarily characterization in project development followed by process monitoring and control in pilot production.

Software supplied with the basic system includes an automatic program generator, diagnostic and calibration programs, current/voltage-curve tracing, and libraries for instrument control and parameter subroutines. These include beta, threshold voltage, breakdown voltage, and resistance. Optional software includes Mosfit for parameter extraction. The applications processor is a Digital Equipment Corp. Micro PDP-11/23+ and a Tektronix Inc. color-graphics terminal serves as the system console. Basic instrumentation starts with 48 pins and six pathways, and two V/I sources. Pricing begins at $65,500, with delivery in 60 days.

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, Ohio 44139.
Phone (216) 248-0400 [Circle 368]

PLUG-IN GIVES PC/XT A SCOPE'S ABILITIES

A plug-in board plus software for an IBM Corp. Personal Computer, PC/XT, or PC AT lets the machine acquire up to 16 channels of analog data with 12-bit resolution at a maximum sampling rate of 1 megasample/s. The ComputerscopeInd's memory depth ranges from 256 points to 16 megapoints.

The board then digitizes waveforms and performs as a digital storage oscilloscope or spectrum analyzer. The subsystem also delivers real-time signal averaging and distortion analysis, and displays data in time-interval and peak-amplitude histograms.

The package including the digital-storage-scope feature starts at $2,495, and other options are available from $795 to $1,495. Delivery takes four weeks.

RC Electronics Inc., 5386-D Hollister Ave., Santa Barbara, Calif. 93111.
Phone (805) 964-6708 Circle 369]

MOTOR DELIVERS 31.7 LB-IN. OF TORQUE

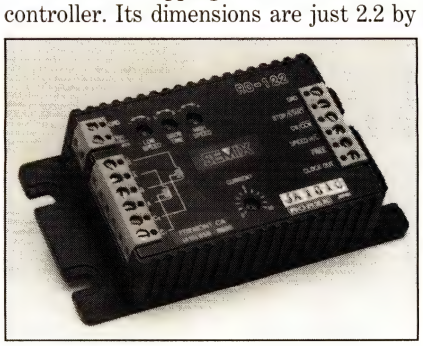
For light-weight, high-torque applications, the BL-24 series of brushless motors delivers from 6 to 31.7 lb-in. in a package whose outside diameter is 3 in. Applications include axis or spindle drivers, nut runners, robotics, antenna drives, and actuators in servo systems.

Some options for the BL-24 series include rear-shaft extensions for attachment of feedback devices including Hall sensors, an optical encoder or a resolver, and customized mountings. A sealed, watertight housing is also available for high-humidity environments. Price range depending on torque is $300 to $900, with delivery in 8 to 10 weeks.

Pacific Scientific, Motor and Control Division, 4301 Kishwaukee St., P. O. Box 106, Rockford, Ill. 61105.
Phone (815) 966-3600 [Circle 353]

DRIVER-CONTROLLER FITS IN SMALL SPACE

Compactness is the chief attribute of the RD-122 stepping motor driver and controller. Its dimensions are just 2.2 by 4.1 by 1.1 in., yet the RD-122 contains both translator and controller.



To create an operational subsystem, the user needs a programmable controller or microprocessor and a power supply—any dc voltage from 18 to 40 V.

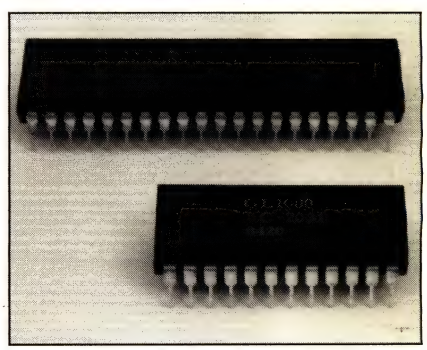
Power efficiency is 70%, so the RD-122 generates a minimal amount of heat. Noise is not a problem either; the casing, a titanium-magnesium-aluminum alloy, shields from electromagnetic interference. Thus the RD-122 can be positioned next to a motor rather than at a distance, eliminating the need to use shielded wiring.

This 2.6-A component delivers 2,400 rpm with adjustable acceleration and deceleration at high or low speeds. Priced at $250, the RD-122 is available now from stock.

Semix Inc., 4160 Technology Dr., Fremont, Calif. 94538.
Phone (415) 659-8800 [Circle 350]

CONTROL ICs NEED NO VELOCITY FEEDBACK

The MCC-3000 motion-control chip set is a general-purpose controller for dc motors, their position, velocity, or torque. There is no limit to the size of the motor the MCC-3000 can control, according to the manufacturer, and no additional velocity feedback is required because the feedback comes from an incremental encoder.



In addition, no analog feedback is required. System stability is achieved by digital filtering—which eliminates the need for a tachometer—and the user can vary the coefficients of the digital filter.

The chip set consists of an interface to RS-232-C and other bus types and to the controller. Ideal for robotics and automation, the manufacturer says, the MCC-3000 offers a zero steady-state velocity error and a speed range of 30,000 : 1.

In quantities of 10,000, the unit price of the set is $49, and delivery takes six weeks.

Galil Motion Control, 1928A Old Middlefield Way, Mountain View, Calif. 94043.
Phone (415) 964-6494 [Circle 351]

PC AT GETS REAL-TIME OPERATING SYSTEM

The RTX286, a real-time multitasking operating system for the IBM Corp. Personal Computer AT, can process a large number and variety of randomly occurring events. RTX286 is a complete implementation of Intel's iRMX286 operating system. It operates in the protected mode with 16-megabyte addressability. The nucleus of the operating system enables it to respond to real-time events.

Protection features for the operating system include a variety of access rights that can be assigned to blocks of memory and several hardware traps that indicate error conditions. Applications for the RTX286 include energy control, robotics, refinery controls, and factory automation.

The RTX286 sells for $2,795. Delivery is in January.

RTCS Corp., 1390 Flynn Rd. Unit E, Camarillo, Calif. 93010.
Phone (805) 987-9781 [Circle 354]

ASSEMBLER PRODUCES 68HC11 CODE

A relocatable assembler for the Motorola 68HC11 microcontroller fully supports the 68HC11's instruction set mnemonically and syntactically.

The assembler, which runs on Digital Equipment Corp.'s VAX, MicroVAX, and PDP-11 computers, provides upward compatibility with most Motorola formatted macros. It provides full relocation facilities, conditional-code and macro functions, and a variety of assembly language features.

The 68HC11 assembler sells for $3,900. Delivery takes 10 days.

Boston Systems Office Inc., 128 Technology Ctr., Waltham, Mass. 02254.
Phone (617) 894-7800 [Circle 356]

IBM PC GETS AI BUSINESS SOFTWARE

Guru is claimed to be the first artificial-intelligence software package for building business applications on the IBM Corp. Personal Computer. The microcomputer-based software works with

uncertainties, uses backward and forward chaining, asks for additional information when needed, provides recommendations, and explains its reasoning.

Guru's business computing tools include relational data management, statistical analysis, comprehensive mathematical capabilities, report generation, business graphics, text processing, remote communications, and a programming language.

Four interfaces—natural-language, menu-guided, English-like command-language, and customized-design—allow users to choose the interface most suitable to their level of ability. Applications for Guru include finance and accounting, management, sales and marketing, administrative, labor, and scientific.

Guru is priced at $2,995 for a single-user system. Delivery is from stock.

Micro Data Base Systems Inc., P. O. Box 248, Lafayette, Ind. 47902.
Phone (317) 463-2581 [Circle 355]

AI SOFTWARE GENERATES COBOL

The Cobol Structuring Facility is a program from IBM Corp. that uses artificial-intelligence techniques to analyze complex programs, structure them into a top-down hierarchy of components, and identify subroutines and procedures for possible reuse in new program development.

The software has two modes of operation—analysis and generation. The first mode analyzes the program and produces a report that identifies unreachable code and endless loops. In generation mode, Cobol/SF organizes the program in a hierarchy of individually structured procedures.

Cobol/SF runs on IBM System/370 mainframe computers. The software sells for $125,000. Delivery will begin in January 1986.

IBM Corp., Information Systems Group, 900 King St., Rye Brook, N. Y. 10573.
Phone (914) 934-4488 [Circle 357]

TESTER CHECKS BOARDS WITH ECL

Mixed-logic pin drivers and monitors on all pins are hallmarks of the System 888X in-circuit tester. Because one driver puts out a negative voltage, the system can test boards packed with ECL circuitry whose operation requires negative logic. The tester has 4,096 nonmultiplexed test points and can be used for testing boards combining ECL and TTL.

The 888X's test-vector rate is 1 MHz, and at clock rates up to 16 MHz, a single test pattern can be applied in 0.5 μs. Windowing allows up to eight distinct clock phases within this time; thus the 888X can send a pulse or set up a monitor window as narrow as 62.5 ns to the device being tested, positioning the pulse or window to 62.5-ns resolution within 0.5 μs.

Priced from $350,000 for a 4,096-pin system, the System 888X is due to be shipped in the second quarter of 1986.

Marconi Instruments, Automatic Test Equipment Division, 292 Gibraltar Dr., P. O. Box 60279, Sunnyvale, Calif. 94088.
Phone (408) 745-7561 [Circle 363]

BOARD TESTER HAS 40-MHz PATTERN RATE

The L290 test system, a board tester whose speed and accuracy approach those of device testers, boasts a basic pattern rate of 40 MHz and channel skew of just ±1.5 ns. To boost its speed even further, the system's 1,152 40-MHz bidirectional test channels can be interleaved for 80-MHz pattern rates on specified channels.

By eliminating dead-time, or portions of the cycle during which signal edges may not occur, the L290 ensures both flexible signal timing and a fine timing resolution of 250 ps. Its large channel-memory capacity—32-K by 4 bits of pat-

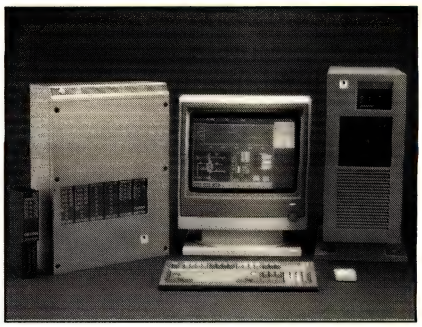
tern RAM—enables the system to execute the long test patterns needed for boards packed with very large-scale ICs.

The L290 test system consists of the computer group supporting a VT241 color CRT terminal, a digital subsystem including channel cards and either a programmable algorithmic pattern processor or a MemTest option, and an analog subsystem with a wide range of analog instruments and a dedicated analog-instrumentation processor. Prices range from $800,000 to $3 million. First deliveries are scheduled for mid-1986.

Teradyne Inc., 321 Harrison Ave., Boston, Mass. 02118.
Phone (617) 482-2700 [Circle 364]

CONTROL SYSTEM AUTOMATES PLANT

The Icon/1000 distributed control system enables engineers to configure complete process-control strategies on screen without conventional language programming. The result is that continuous, batch, and sequential processes can be automated for a fraction of the cost of large distributed systems.



The system is built from two hardware elements—a graphics work station based on IBM Corp.'s 7531/2 Industrial Computer (the industrial version of the Personal Computer AT) and a dedicated intelligent controller on the plant floor. Software is Cape (computer-aided process engineering).

Cape drafts process diagrams onto the work station's screen using standard Instrument Society of America process icons. Icon/1000 handles from 12 to hundreds of loops over a maximum of 254 controllers and work stations. The price of a basic configuration starts at $67,500, and first production deliveries will start in May 1986.

Data Acquisition Systems Inc., 349 Congress St., Boston, Mass. 02210.
Phone (617) 423-7691 [Circle 359]

SYSTEM ANALYZES FACTORY-FLOOR DATA

A productivity tool, Firms (factory integration and resource management system), works with Teradyne's J967 and J983 very large-scale IC test systems, collecting data generated on an electronics factory floor and distributing it to other parts of the factory over Ethernet. With a Firms network system, users can remotely log on to a test system from a Digital Equipment Corp. VAX terminal, or to the VAX host minicomputer from the test system.

RS/1 data-analysis software is at the heart of Firms. RS/1 integrates the raw data then enables the device manufacturer to analyze it and fine-tune ongoing operations based on the results. For example, the manufacturer can detect lot-to-lot variations or keep a history of yield and performance by vendor.

The V900 model of Firms, running on a MicroVAX II, sells for under $100,000, including the software for communications between the test system and the host computer. Deliveries will begin in the first quarter of 1986.

Teradyne Inc., 321 Harrison Ave., Boston, Mass. 02118.
Phone (617) 482-2700 [Circle 361]

SYSTEM CONTROLS 24 PROCESS LOOPS

The Yewpack Mark II process-control system serves small to medium-size operations that need to monitor and control from 8 to 24 loops. It consists of an operator console and up to eight field-control units.

The manufacturer calls it an easy-to-engineer, compact, low-cost version of its Centum process-control system. Various control I/O cards perform continuous-process control, and software written in Basic performs batch and sequence control. No host computer is required to supervise the system—instead, software performs host functions.

Five operator stations and eight field-control units can be linked over a single coaxial cable, and up to two printers can be linked to each operator station. Both an operator keyboard with dedicated

keys and an engineer typewriter keyboard for programming are incorporated into the operator station.

The basic system—console, control unit with cards and cables, and software—sells for $31,000. Delivery takes 14 weeks.

Yokagawa Corp. of America, 2 Dart Rd., Shenandoah, Ga. 30265.
Phone (404) 253-7000 [Circle 360]

PIEZOELECTRIC FAN USES JUST 50 mW

A 12-V dc piezoelectric fan moves 0.8 ft^3/min of air while it consumes only 50 mW. A 24-V version moves 1.5 ft^3/min using less than 200 mW. The fans produce negligible radio-frequency and electromagnetic interference, and there is no power surge on startup, according to the manufacturer.

Fans in the series LP-1200 are wave-solderable; their small outside dimensions and low weight—0.6 oz—recommend them for tightly packed circuit boards. Applications include temperature-control systems and battery-operated instruments.

An evaluation design kit for thermal-

layout problems is available. The fans sell for $250 each, and delivery takes four weeks.

Piezo Electric Products Inc., 240 N. Washington Blvd., Sarasota, Fla. 33577.
Phone (813) 366-1458 [Circle 362]

3½-IN. WINCHESTERS STORE 30 MEGABYTES

The PT 325 and PT 338 belong to a family of 3½-in. Winchester disk drives with 20- and 30-megabyte capacities, 40-ms access times, and industry-standard ST506 interfaces.

The PT 325, the 20-megabyte model, and the PT 338, the 30-megabyte model, both feature a head-lock mechanism that offers complete protection in portable and other rugged applications. Automatic head retraction during power down moves the heads into a landing zone to assure data integrity and reliability. A closed-loop servo positioning system provides rapid access.

The PT 325 sells for $360 and the 338 for $450 in large quantities. Sample models will be available in the first quarter of 1986; production quantities during the third quarter of 1986.

Peripheral Technology Inc., 9176 Independence Ave., Chatsworth, Calif. 91311.
Phone (818) 709-8877 [Circle 372]

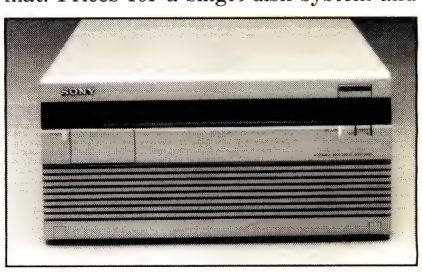
OPTICAL DISK DRIVE HOLDS 3.2 GIGABYTES

Sony's writable optical-disk system provides high-density storage of scientific and business data, government intelligence information, and digitized images of archival documents.

The system comes in two configurations: a single writable disk drive with controller and an autochanger that can hold up to 50 disks.

The disk is made of two metallic elements sealed in a polycarbonate plastic. When a laser beam writes information on the disk, it turns the elements into an alloy that has different reflective properties.

The disk measures 12 in. in diameter and is housed in a protective cartridge. It holds up to 3.2 gigabytes in a constant linear-velocity format or 2.1 gigabytes in a constant angular-velocity format. Prices for a single-disk system and



controller range from $6,000 to $9,000. The disk is available immediately from stock; the autochanger will be available during the second quarter of 1986 for about $90,000.

Sony Information Products Division, Sony Drive, Park Ridge, N. J. 07656.
Phone (201) 930-6432 [Circle 374]

TAPE DRIVES FIT IN 3½- and 5¼-IN. SLOTS

A series of mini data cartridge drives developed by 3M come in 3½- and 5¼-in. form factors. The drives will give microcomputer users 40 megabytes of fully corrected capacity using 3M's DC2000 ¼-in. mini data cartridge.

The drives, which are suitable for disk backup, file storage, and data-base and software distribution, feature a patented error-detection and -correction scheme. They use the industry-standard Small Computer Systems Interface, with

which systems integrators can easily incorporate the drive into their systems. Both drives use the Qic-100 data format to provide reliable data interchange between systems.

The mini data cartridge drives sell for just under $300 in large quantities. Delivery is from stock.

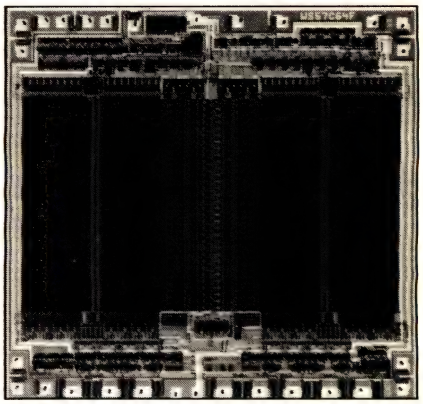
3M Co., P. O. Box 33600, St. Paul, Minn. 55133. Phone (612) 736-2355 [Circle 373]

FAST ERASABLE PROM HAS NO WAIT STATES

A 64-K ultraviolet-erasable PROM with an access time of 70 ns does away with wait cycles, recommending it for storing programs for high-speed computing applications. Organized as 8-K by 8 bits, the WS57C64F interfaces with bus organizations of 8, 16, and 32 bits. Either the output-enable or the chip-enable control signal can be used to place the part's three-state outputs in the high-impedance state—an important feature in any shared-bus environment.

The WS57C64F is inactive 50% of the time and offers a power-down mode for those periods. During inactive times, the power consumption of the CMOS EPROM falls from 300 to 1 mW. Use of epitaxial wafers ensures immunity to

MEMORIES



latchup, with protection greater than 100 mA and electrostatic-discharge protection in excess of 2 kV.

Programming time is less than 16 s for the EPROM, which comes in a standard 28-pin Cerdip. In volume orders, the WS57C64F sells for $28; samples will be available this month.

Waferscale Integration Inc., 47280 Kato Rd., Fremont, Calif. 94538. Phone (415) 656-5400 [Circle 377]

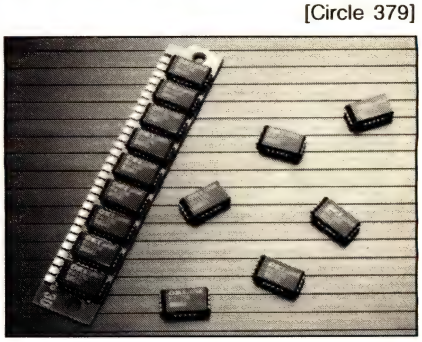
2-Mb RAM MODULES SAVE BOARD SPACE

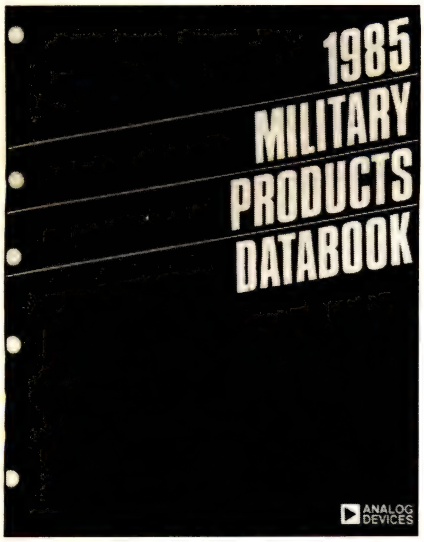
To form this single in-line memory module, the maker packaged 256-K dynamic-RAM chips—more than 2 Mb worth—in plastic leaded chip carriers and mounted them on the surface of a standard epoxy-glass substrate, forming small pc boards. The advantages of this construction include ease of field repair and saving of board space, the company says.

Two basic types of SIMM are available. One is organized into 256-K 9-bit words; the other module has an 8-bit-wide organization. Both are offered in 120- and 150-ns row-address speed versions and in two package types—one with an edge connector and one with pins for through-hole mounting.

Typical power dissipation ranges from 138 mW in standby mode to 2.75 W in operation. The 150-ns model costs $35 each in lots of 10,000 pieces. Delivery is from stock.

Oki Semiconductor Inc., 650 N. Mary Ave., Sunnyvale, Calif. 94086. Phone (800) 336-3555; in California, (408) 720-1900 [Circle 379]





MIL-STD ICs. The 480-page *Military Products Databook* contains device specifications for monolithic and hybrid ICs that comply with MIL-STD 883, Revision C. Published as a resource for military-system-component engineers, the free data book contains information on such products as analog-to-digital and digital-to-analog converters, operational amplifiers, and analog and digital signal-processing components. The products are cross-referenced to MIL-M 38510. Contents are organized under general and detailed specifications, a selection guide, package specifications, and a model-number index. Address requests to Analog Devices Inc.'s Literature Center, 70 Shawmut Rd., Canton, Mass. 02021. [Circle reader service number 421]

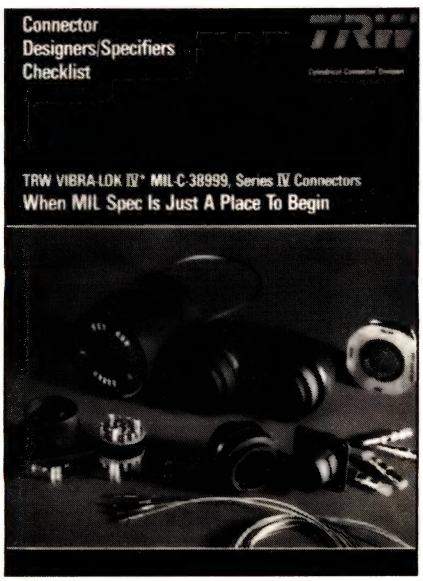
MOTORS. A free brochure highlights the ServoDisc, a dc servo motor that employs a flat-disk ironless armature consisting of several layers of flat conductors. The absence of iron eliminates cogging at low speeds and eddy-current losses, the manufacturer says. Short descriptions and color illustrations also appear for Ferrite-Series motors and motor parts, gear motors, encoders, servo amplifiers, and custom motors. Call PMI Motion Technologies (formerly PMI Motors), a division of Kollmorgen Corp., at (516) 938-8000 to request a copy of the brochure, or write to the company at 5 Aerial Way, Syosset, N. Y. 11791. [Circle 422]

EMI SOFTWARE. Application Note 330-1, "Automatic MIL-STD EMI Testing Using the HP 85864A/B EMI Measurement Software," has 26 illustrations depicting menu tables, test setups, sample programs, and CRT responses. The test examples are derived from MIL-STD-461B, but the procedures also apply to other MIL-STD and electromagnetic-interference measurements. The software automates the HP 8567A, 8566B, and 8568B spectrum analyzers. For a free copy of the 22-page note, write to the Inquiries Manager, Hewlett-Packard Co., 1820 Embarcadero Rd., Palo Alto, Calif. 94303. [Circle 423]

SECURE TELECOMMUNICATIONS. "Protection of Government Contractor Telecommunication" is an unclassified composite of Defense Department directives in the important area of Comsec communications security. Approved contractors can now purchase Comsec equipment directly for secure classified and sensitive telecommunications. Bendix Aerospace, whose Secure Telecommunications Division compiled this booklet, is an authorized vendor under the program. The book is free to anyone making a written request to Bendix Communications Division, 1300 E. Joppa Rd., Baltimore, Md. 21204. [Circle 424]

KNOWLEDGE-BASE SYSTEMS. A new journal, *Data & Knowledge Engineering,* contains original-research results, information on technical advances, and news items in the fields that are indicated in its title. These areas include new architectures for data-base, knowledge-base, and expert systems; design and implementation techniques; languages and user interfaces; and distributed architectures. A sample copy of the journal is available free of charge from the publisher, North-Holland, c/o Elsevier Science Publishing Co., P. O. Box 1663, Grand Central Station, New York, N. Y. 10163. Phone (212) 867-9040. [Circle 425]

CONNECTORS. The "Connector Design/Specification Checklist" is offered free as an aid for designing under MIL-C 38999 connector requirements. The checklist organizes data into seven categories, including design objectives, timetables, environmental factors, and criteria such as shell size, material selection, mounting requirements, and contact selection. The company's Vibra-Lok IV connectors are featured, available in ultrashock, firewall-engine, and other standard and custom configurations. For a copy, call the Cylindrical Connector Division of the TRW Electronic Components Group at (612) 537-1010, or write to the division at 8821 Science Center Dr., Minneapolis, Minn. 55428. [Circle 426]



PRICE CONFIRMATION. A free leaflet, Release No. 85-76, describes a price handbook developed by the Defense Electronics Supply Center. The handbook profiles price ranges in some 600 item groups and indicates to the prospective buyer what should be the usual price for the type of item as well as the maximum a buyer should expect to pay. Where prices seem to be excessive, the center asks the supplier to furnish data and substantiate the cost. The data base was developed by the Center's Office of Policy and Plans. Further information on the price-screening program is available from DESC's Public Affairs Office, 1507 Wilmington Pike, Dayton, Ohio 45444. Phone (513) 296-6421. [Circle 427]

REMOTE TERMINAL. An 18-page data sheet describes the Bus-65112 dual-redundant remote terminal unit, which meets MIL-STD 1553. The 2-by-2-in. hybrid includes two transceivers, two bit processors, remote-terminal-unit protocol, data buffers, and timing-control logic. The free data sheet contains a full description of the device, features, and technical specifications, as well as a block diagram and outline drawings. Copies are available from the Marketing Department of ILC Data Device Corp., 105 Wilbur Place, Bohemia, N. Y. 11716, or call (516) 567-5600. [Circle 428]

FANS. A free 24-page catalog of electronically commutated brushless dc fans and blowers covers models that meet MIL-B 28873. For cooling electronic components, the products can be run at lower speeds than ac fans, according to the manufacturer. They also consume less power and are quieter. The catalog includes technical specifications, detailed dimensions, schematics, and performance parameters. Call or write to EG&G Rotron, Custom Division, Woodstock, N. Y. 12498. Phone (800) 431-6033 or, in New York State, (914) 679-5201. [Circle 429]

MEETINGS

OPTICS TO GET WIDE AIRING AT O-E/LASE '86

LOS ANGELES

By organizing 21 separate conferences and over 500 papers, the International Society for Optical Engineering is covering a broad spectrum of optical and laser applications at its O-E/Lase '86 symposium. They run from optical computing to manufacturing applications of lasers to optic and laser technology in medicine.

The symposium is so broad-based that there are several conferences not directly related to lasers or optics. One that could draw a lot of interest covers developments in advanced processing and characterization of semiconductors.

"Rapid thermal processing has always been sort of popular. Now it's maturing," says Michael I. Current, cochairman of O-E/Lase '86, which runs Jan. 22-24. When the organizers went after papers on a subset of that topic—rapid thermal annealing—they "got them easily, indicating a lot of interest." He adds the annealing process "still has a way to go before it becomes mainstream production, but not that far." It is getting more attention, he says, because of the slowdown in the semiconductor industry. "If there's one bright thing about a slow economy, it's that people have more time on their hands to try new things."

Also featured at the symposium is a conference on amorphous semiconductors, chaired by David Adler of the Massachusetts Institute of Technology. Another conference covers laser processing of semiconductors and hybrids, and includes a paper on laser-assisted etching and three-dimensional semiconductors.

Winter CES, Electronic Industries Association (2001 Eye St. N. W., Washington, D. C. 20006), Hilton Hotel, Sahara Hotel, and Convention Center, Las Vegas, Jan. 9-12.

Winter Consumer Electronics Conference, IEEE (Scott Cutler, Tandy Corp., 1300 Two Tandy Center, Fort Worth, Texas 76102), Hilton Hotel, Las Vegas, Jan. 11.

5th Symposium on Reliability in Distributed Software and Database Systems, IEEE (IEEE Computer Society, 1730 Massachusetts Ave. N. W., Washington, D. C. 20036), Los Angeles Marriott, Jan. 13-16.

Smart II: Surface Mount and Reflow Technology Conference, Electronic Industries Association and Institute for Interconnecting and Packaging Electronic Circuits (EIA, Smart Conference, 2001 Eye St. N. W., Washington, D. C. 20006), Los Angeles Airport Hilton Hotel, Jan. 13-16.

The MAP Users' Group Meeting, Society of Manufacturing Engineers (1 SME Dr., Dearborn, Mich. 48121), Sheraton Centre, Toronto, Jan. 15-16.

1986 Winter Usenix Technical Conference, Usenix Association (Usenix Conference Office, P. O. Box 385, Sunset Beach, Calif. 90742), Marriott Hotel-City Center, Denver, Jan. 15-17.

Forum '86, Recognition Technologies Users Association (P. O. Box 2016, Manchester Center, Vt. 05255), Dallas Marriott Hotel, Dallas, Jan. 19-22.

O-E/Lase '86, International Society for Optical Engineering (P. O. Box 10, Bellingham, Wash. 98227-0100), Los Angeles Marriott and Airport Hilton hotels, Jan. 19-24.

ASEE '86: Advanced Semiconductor Equipment Exposition & Technical Conference (Cartlidge & Associates Inc., 1101 S. Winchester Blvd., San Jose, Calif. 95128), San Jose Convention Center, Jan. 21-23.

World Conference on Electronic Printing and Publishing, George Washington University, (Henry B. Freedman, Electronet Information Systems Inc., 2000 Pennsylvania Ave. N. W., Washington, D. C. 20006), George Washington University, Jan. 22-24.

1986 SCS Multiconference, Society for Computer Simulation (Simulation Councils Inc., P. O. Box 2228, La Jolla, Calif. 92038), Bahia Hotel, San Diego, Jan. 23-25.

Crosstalk '86, EIA (EIA, Crosstalk '86, 2001 Eye St. N. W., Washington, D. C. 20006), Hyatt Palm Beaches, West Palm Beach, Fla., Jan. 26-29.

1986 Reliability and Maintainability Symposium, IEEE (Norman Kutner, Westinghouse Electric Corp., 401 E. Handy Ave., Sunnyvale, Calif. 94088), Riviera Hotel, Las Vegas, Jan. 28-30.

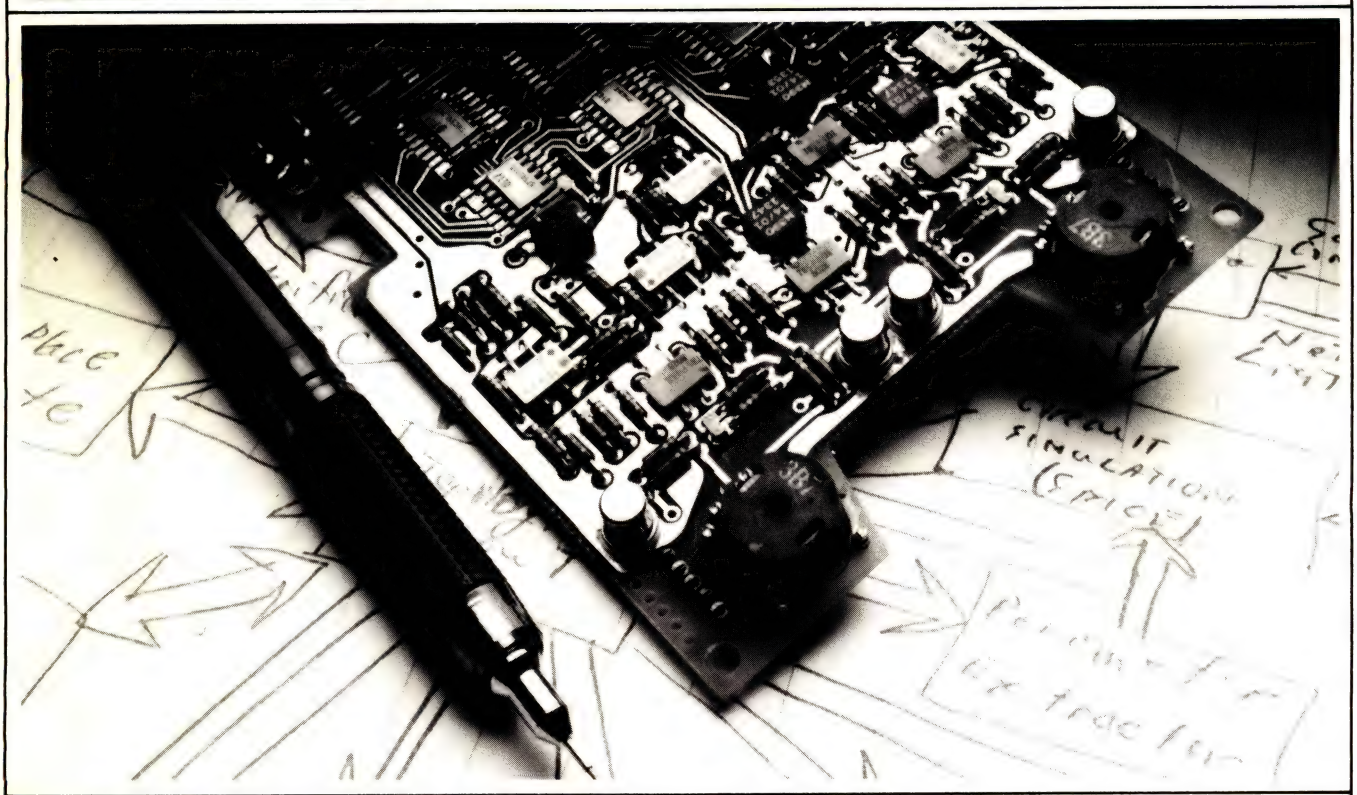
Communications Networks '86, CW Communications Inc. (P. O. Box 880, Framingham, Mass. 01701), Washington Convention Center, Washington, Jan. 28-31.

ASTM International Symposium on Semiconductor Processing, American Society for Testing and Materials (1916 Race St., Philadelphia, Pa. 19103), Red Lion Inn, San Jose, Calif., Jan. 28-31.

Robotic Industries Association Meeting, Robotic Industries Association (P. O. Box 1366, Dearborn, Mich. 48121), Sheraton, Scottsdale, Ariz., Jan. 29-31.

Engineers and other high tech professionals

Are your plans bigger than your employers?



Engineers often work for big companies on big projects. Accordingly, they make big plans for their future. But if you've ever worked for a large company you know that you can plan on one thing for certain: that your best efforts—much like your aspirations—often go unrecognized.

A Big Difference

At Martin Marietta Denver Aerospace, you'll find that we have a different way of working together. Our matrix organizational structure gives you more opportunity to advance your career quickly. We planned it that way.

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Today, Martin Marietta is growing faster than ever. And while we already have some of the finest facilities in the world, at the foothills of the Rocky Mountains in Denver, Colorado, we're investing millions more to expand them.

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RESUMES

Resumes — Complete instructions and examples; $4, Consultants, Box 567—J, Bergenfield, N.J. 07621.

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ELECTRONICS WEEK®

NEW PROBE OF JAPANESE DUMPING

For the first time, the Commerce Department has initiated an investigation against Japanese memory-chip makers before receiving an industry complaint. The Reagan Administration on Dec. 6 told the department to investigate whether Japanese 256-K dynamic random-access memories are being sold below cost. More important, the department will for the first time try to anticipate technological change by imposing dumping penalties that would apply to next-generation 1-Mb memory chips. Meanwhile, negotiations to resolve the Semiconductor Industry Association's complaint under Section 301 of the Trade Act were broken off abruptly by the Japanese delegation. The SIA has demanded open access to Japanese markets and an end to what it calls predatory pricing of ICs in the U. S. The Japanese walked out after U. S. negotiators rejected their settlement proposals.

MOTOROLA SUES OVER 68000 PACT

Motorola Inc. courted Mostek Corp. in 1981 to become a second-source partner for the 68000 microprocessor line. Now Motorola wants to see Mostek's former owner, United Technologies Corp., in court. A federal suit filed in Dallas claims UTC had earlier violated Mostek's licensing pact with Motorola by releasing confidential information on the 68000. Motorola now seeks more than $20 million in damages, plus a punitive award, from UTC.

AT&T LANDS BIG ONE FROM BOEING...

Boeing Computer Services Co., Seattle, will add $100 million in digital switching equipment purchased from AT&T Information Systems to its 68-million-line telephone network. The equipment will go to Boeing Co.'s four main facilities in Puget Sound, Wash.; Philadelphia; Vienna, Va.; and Wichita, Kan. The switching capability makes Boeing in effect one of the country's largest telephone companies.

...AND ANOTHER FROM THE FEDS

AT&T Co. has been chosen to provide the U. S. House of Representatives with telecommunications equipment. The House Administration Committee picked AT&T over Northern Telecom, IBM-Rolm, and Chesapeake & Potomac Telephone, the Washington-area affiliate of Bell Atlantic Co. AT&T will now negotiate a contract for 10 years that could total $16 million. However, C&P Telephone filed a protest claiming it was the lowest bidder by a wide margin and had the best technical solution. If C&P loses its protest, as expected, and contract negotiations are successful, AT&T will build two System 84 private branch exchanges to be installed on Capitol Hill.

HUNGARY EYES WEST'S HIGH TECH

The Hungarian Council of Ministers has approved a multifaceted program to increase the use of electronics in the country by, in part, expanding its reliance on Western technology. The plan envisions a far-reaching set of research and development programs to expand the role of technology in industry, agriculture, transportation, communications, and construction. The central government will reduce customs tariffs to cut costs, and offer tax concessions to foster the purchase of the most advanced technologies. Besides agreements with Comecon, the ministers approved extending cooperation with Western countries by stepping up the purchase of licenses and know-how. Planned purchases include flexible production systems, robots, and computer-aided-design systems.

CONVEX COMPUTER TARGETS JAPAN

As part of a new thrust into Japan's scientific computer market, Convex Computer Corp. of Richardson, Texas, plans to establish a subsidiary in Tokyo early next year and says it has signed contracts with original-equipment manufacturers. Convex KK will market the company's C-1 64-bit minisupercomputer through Tokyo Electron Ltd. Convex also named Digital Computer Ltd. of Tokyo as a private-label OEM supplier. The two contracts are valued at a total of $25 million.

LONGEST FIBER LINK BEGUN

MPX Systems, a subsidiary of Scana Corp. of Columbia, S. C., has begun construction of the longest overhead fiber-optic communication link in North America. Expected to take six months to complete, the 129-mile-long link will be used primarily for internal communications for South Carolina Electric and Gas Co., Scana's largest subsidiary. MPX will market excess capacity to long-distance telephone carriers. The line's lasers can transmit 405 Mb/s. Company officials say they expect to triple the system's speed and capacity within the next two years.

HITACHI BUILDS U. S. DISK-DRIVE PLANT

Japan's Hitachi Ltd. is choosing local production in the U. S. rather than increasing its export ratio to reduce "trade friction between the two countries." A Hitachi spokesman says the Tokyo electronics giant is building a $9 million factory in Norman, Okla., to produce large-scale disk drives for mainframe computers. The company is considering opening a plant to make video cassette recorders despite what company officials say is "stagnation and saturation" in the VCR market. The plants are part of Hitachi's effort to follow Japanese Prime Minister Yasuhiro Nakasone's guidelines to improve U. S.-Japanese trade relations. In addition, Hitachi said the disk-drive plant could help its campaign to become competitive in the U. S. mainframe marketplace.

AT HONEYWELL, LAYOFFS...

In response to the continuing downturn in the computer business, Honeywell Inc. has laid off 600 people from its Small Computer and Office Systems group based in Billerica, Mass. The layoffs coincide with a reorganization that places increased emphasis on sales to the converging small-computer and office-systems markets, which will be coordinated by a new Office Marketing Systems Division. Honeywell also says it will introduce a 32-bit virtual-memory superminicomputer in mid-1986.

...BUT AT HP, LONGER HOURS

For Hewlett-Packard Co., the slump may be disappearing. On Jan. 1, the Palo Alto company is putting some of its U. S. staff back on full-time schedules until April because of "modest improvements" in order rates. The exact number will be up to HP divisions, but a company spokesman believes all workers at most divisions will be reactivated full time. HP will reassess the industry during that time to decide what happens afterward. Affected by the time-off program, which HP started earlier this year, were 45,000 employees—48% of whom are clerical and production workers.

Sperry Technology: Preparing for tomorrow's challenges

Sperry's Space Systems Division is preparing for tomorrow's challenges. We are providing technology for the Space Station and Space Shuttle. We are developing technology for a number of other Space based projects. We need experienced engineers to join us in Phoenix, a fast growing city which offers you a year-round outdoor lifestyle. We have openings in the following areas:

Attitude Control System Engineers

ACS Design

In this position you will be responsible for the development of system requirements and specifications and for the definition of interface documents and system hardware. You will develop error budgets, flowdowns of requirements and the process for designing attitude control systems (ACS). Experience in ACS system design and trade studies is desired for this position.

Attitude Determination

This position calls for a control systems engineer with a background in attitude determination, reference and control. You will develop the algorithms for attitude reference and define ACS interfaces with the Attitude Reference System. Your experience should include analysis of Attitude Reference Systems and knowledge of inertial measurement components.

Control Systems Design

Challenging positions exist at all levels of experience in spacecraft attitude control, pointing systems, and electro-mechanical servomechanism design. To qualify for these assignments you will need five or more years experience in the synthesis of servomechanisms. You will participate in the development of control systems for high gain antennas, solar array drives and momentum exchange devices. Experience in the conceptual design, synthesis, analysis and simulation of control systems for orbiting applications is desirable.

Test Systems Engineers

Hardware and software positions are available for the development of test systems for spacecraft attitude control systems and components. Positions open include test system design, test hardware development, test software development and system simulation. To qualify for software and systems positions, you should be familiar with HP-1000 and HP-9800 series hardware and software or with the MC6800 microprocessor, Unix operating system, "C", and ATLAS languages. Test hardware development will require a background in analog or digital circuit design.

Integration/Test Engineers

In this assignment you will prepare for and execute the integration and test of spacecraft attitude control components and spacecraft mechanisms. Activities will include test planning and procedure generation, test fixture specification, test monitoring, failure investigation and orbital anomaly analysis. You should have experience in integration and testing of complex electromechanical systems and be familiar with spacecraft attitude control components and automated test systems.

Electronic Engineers

Assignments at all levels involving synthesis, analysis and development of high-reliability aerospace hardware. You will be involved with the application of analog and digital electronics in both signal and power handling circuits. Hands-on hardware experience is desired.

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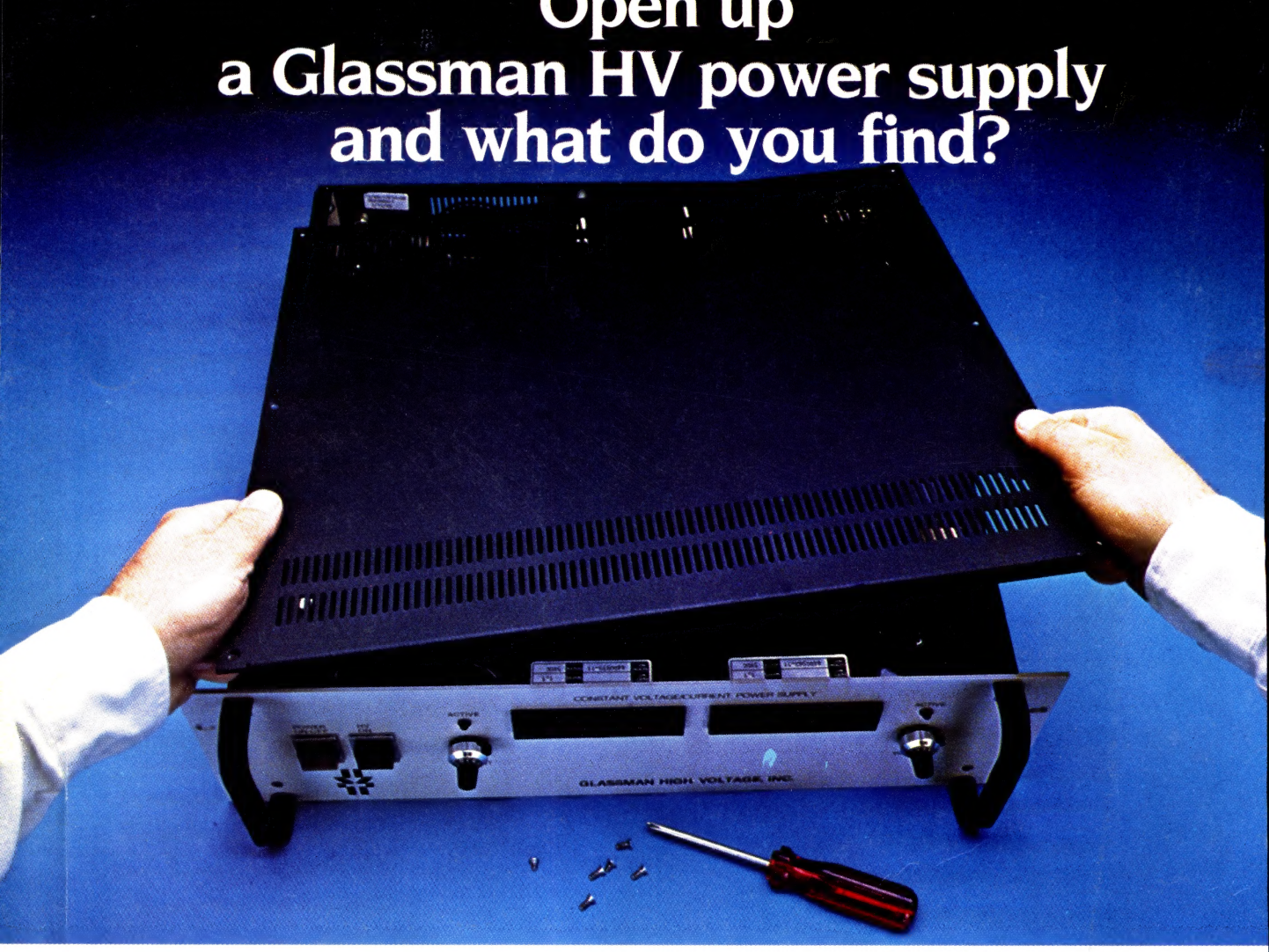

AIR...

Plus, a few components. Together, they comprise the most sophisticated high voltage DC power supply you can buy.

Because air is the primary insulating medium for all Glassman power supplies, they are lightweight, small, and low cost. Their conservative design margins give you long component life. And keeping the units free of oil and potting compound makes it easy to service them if something finally does wear out.

But compactness and durability are not all you get in Glassman's advanced designs. Inherent in each model is exceptionally tight regulation (better than 0.005%, both line and load, on most models), low ripple, and exceptional efficiency resulting in low internal dissipation and high reliability.

And you get choice. If your high voltage DC power requirements fall somewhere between 0–3KV and 0–400KV, up to 5,000 watts, one of our more than 300 standard models will probably meet your requirements. Plus, our standard options give you the possibility of thousands of alternate models. If none of these are what you need, our staff will work with you to create a unit to meet your project goals.

For a closer look at what's inside a Glassman power supply, call John Belden at 201-534-9007 or return the coupon at left.

John:
I want to get a better look at what's inside one of your power supplies. My applications might range from:
0 to _____ KV @ 0 to _____ mA;
to 0 to _____ KV @ 0 to _____ mA.

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Innovations in high voltage power supply technology.

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